CHEMICAL
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MOUNTAINS OF FERTILIZER FOR EXPERIMENT

BOTH the fertilizer industry and chemical engineers in general have been intensely interested in the investigations of electric furnace phosphoric acid and triple superphosphate manufacture conducted by the Tennessee Valley Authority. Out of this, and through cooperation with Agricultural Experiment Stations, has come much useful information on both manufacture and use.

In June and September, 1935, we published two articles describing the plant and telling of many of the operating problems encountered. Now, with another year's experience behind them, the engineers in charge of the plant have consented to give CHEM. & MET. readers the benefit of their later observations. The first article, dealing with operation, will be found in the August issue. The second, on operating costs, will appear shortly.

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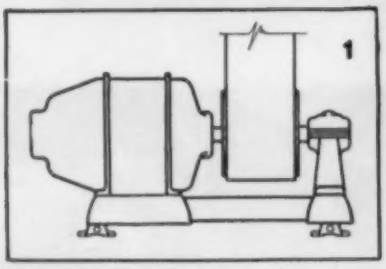
...for the RIGHT answer to any speed reduction problem.....

LINK-BELT POSITIVE DRIVES



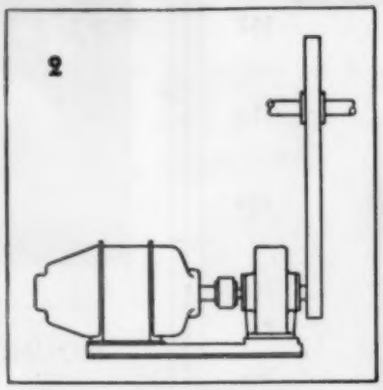
150 Horse Power—570 R.P.M. Motor
Flat belt drive
Outboard bearing
Slide Rails
Driven shaft operates at 70 R.P.M.

Sketches No. 1 and No. 2. An example indicating one of many relative advantages of the Link-Belt Herringbone Gear Speed Reducer.

Assuming a drive is required to transmit 150 horse power from an electric motor to a shaft operating at 70 R.P.M. If a flat belt or V-belt drive is used (Sketch 1), a 570 R.P.M. motor would be necessary.

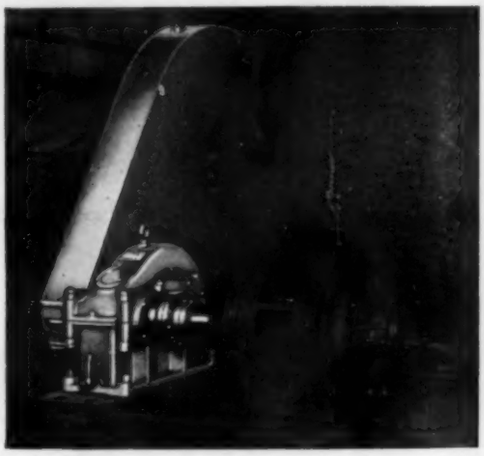
Using the combination of a single reduction Herringbone Reducer and a Roller Chain Drive (Sketch 2), permits the selection of an 1150 R.P.M. motor, with the following advantages:

1. Compactness.
2. Ease of installation.
3. Greater flexibility in arrangement and location of motor.
4. More efficient, smaller and less costly motor.
5. Lower installation cost.
6. Provision for increasing or decreasing speed of driven shaft by changing ratio in sprocket wheels.
7. Total cost of installation is less than for drive using flat belt or V-belt.



150 Horse Power—1150 R.P.M. Motor
Flexible Coupling
Size S-14 Single Reduction Link-Belt Herringbone Gear Reducer
Link-Belt "RC" Class Roller Chain Drive
Driven shaft operates at 70 R.P.M.

Below: Illustration of an actual Link-Belt Positive Drive installation. A 20 H. P. motor, transmitting power to Link-Belt herringbone gear reducer and an encased Link-Belt Silverlink roller chain drive. A typical example of a Link-Belt reducer installation.



Because Link-Belt makes all three types of speed reducers—the Herringbone Gear Type—the Worm Gear Type—the Motorized Helical Gear Type—our recommendations are wholly unbiased in determining the correct reducer for each application.

Catalogs on any or all Link-Belt reducers sent on request. For the complete Link-Belt line of Positive Drives ask for Binder 2100. Address Link-Belt Company, Indianapolis, Chicago, Philadelphia, Atlanta, San Francisco, Toronto, or any of our offices in principal cities.

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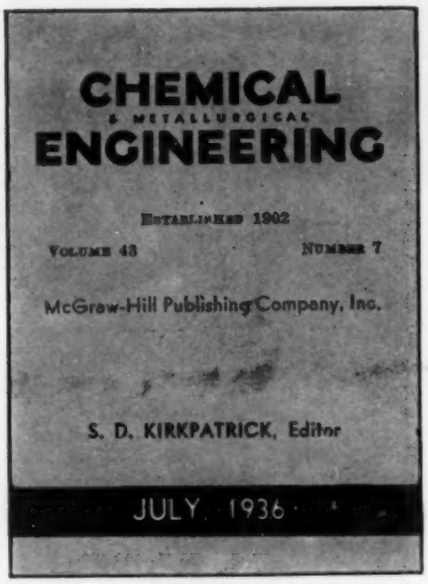


NO WATER-TIGHT COMPARTMENTS FOR CHEMICAL ENGINEERS

AN OCEAN LINER is logically constructed with water-tight compartments, yet we have recently had occasion to observe that the bulkheads are closed only in preparation for an emergency. We wonder, however, how much of our thinking as engineers is done in water-tight compartments between which the bulkheads are never opened? How much of our professional activity is similarly restricted to our own fields of immediate interest. How narrowly nationalistic are our ambitions for industrial and technical progress? These questions, as you may surmise, have been prompted by pleasant contacts with chemical engineers from many countries, assembled here in London for the first International Chemical Engineering Congress.

One topic of discussion that arises inevitably in such groups is the subject of education in our technical colleges and universities. There, perhaps more than in any place else, may be found the beginnings of a dangerous trend toward overspecialization. Too often in our modern curricula we set up water-tight compartments and lock the bulkheads between them. Chemistry, physics and mathematics are taught without reference to each other—or in their proportionate relation to the whole of chemical engineering. Calculus, instead of being recognized as a useful tool for a subsequent course in physical chemistry or unit operations, becomes something to be forgotten just as soon as the final exam is passed.

Fortunately this sorry state of affairs does not exist as often in American schools as it did a decade or two ago, but there is still a need in many of our institutions for better orientation to guide the student toward a well-rounded educational objective.

In industry today, except in the very largest corporations, there is no urgent need for further specialization, especially on the part of the chemical engineer. His abilities should be available for a wide variety of applications in the industrial organization. He must be flexible, at the same time competent and thorough. He can and should help to break down the water-tight compartments of the over-integrated business structure.

As between countries, there are many reasons why chemical industries have developed along nationalistic lines, but certainly chemistry and chemical engineering need not recognize geographical boundaries. New processes and equipment are of interest the world over and a free interchange of ideas is certain to prove helpful even when economic and political conditions preclude the oversea sale of goods and machinery.

International gatherings, such as this Congress in London that has brought together almost a thousand chemical engineers from thirty different countries, cannot help but have constructive results and implications. Something has been started which can develop into a powerful agency, serving an ever-broadening function in process industries throughout the world.

London, July, 1936

Sidney D. Kirkpatrick

FROM AN EDITORIAL VIEWPOINT

Anderson expellers in the new soybean plant of the Glidden Co. at Chicago

» Constructive Outcome of a Controversy

AS WE have averred before, the undignified and unprofitable controversy that has raged over power alcohol has been premature, unnecessary and based on an incomplete consideration of the facts. For there have been no complete facts, at least so far as American conditions are concerned, and the facts as regards power alcohol go far beyond either the simple economics or the simple technology of the question. Those who would help the farmer through "Chemurgical Engineering" have declared for the production of alcohol from grains for admixture with gasoline. Opposing them, the petroleum people and many others have been horrified at the political implications and outraged at the economics. But it is clear that preconceived notions so far have been substituted for facts, for there have been no facts.

We, ourselves, hold no brief for power alcohol as a fuel; and as a farm panacea we reserve decision. But we do hold for the experimental approach, even to problems that involve more of politics and economics than of chemical engineering. Happily, The Chemical Foundation has determined on this course, as the alcohol plant now starting operation at Atchison, Kansas, will testify. It may be argued that the one plant described elsewhere in this issue is far too small to demonstrate anything conclusively. But that is not the point. The way has been paved to further demonstration plants and others will be built. Power alcohol is to have its day in the sun and an opportunity to show whether it is a boom or a blow at national well-being.

» Progress Report on Domestic Potash

ON THE authority of the United States Bureau of Mines, domestic consumption of potash materials in 1935 amounted to 930,893 tons, of

which about 43 per cent was of domestic origin. In this statement is found evidence of the evolution of a home industry—an industry which was regarded as highly desirable in 1911 when relatively low-priced contracts held by American consumers were abrogated by placing foreign production under government control, followed by the placing of surtaxes on shipments to this country; an industry which was regarded as necessary when the World War shut off all importations. With foreign sources of supply closed, every effort, both governmental and private, was directed toward the development of production in this country. Official records for production in the last few years bear witness to the success which has accompanied those efforts. In 1935 the home output of potash salts was the largest on record, reaching a total of 357,974 short tons with a potash content of 192,793 short tons.

This result was achieved in the face of the keenest kind of competition, since cartel control in Europe was disturbed by greatly increased production in non-member countries, notably Russia and Spain, and the resultant struggle for consuming markets brought prices to a new low level. Attempts to aid the home industry through the imposition of import duties have failed because potash is an important material in the manufacture of fertilizers of which the farmer is the ultimate consumer. The recent advance in prices for potash gives credence to the report that foreign producers have reached an accord which will probably include the allocation of consuming markets. The future of the domestic industry would be rendered more secure if imports into this country were placed on a quota basis.

»Profits From Wastes

FEDERAL, regional, and state organizations are devoting considerable time and effort to the problem of stream pollution by industrial plants. As the sulphite pulp mills are constantly threatened by regulations which might force many to stop production, it is particularly interesting to follow the progress that Guy Howard and his associates at the Marathon Paper Mills Company are making in the development of a method for improving the mill effluent.

In a recent progress report to the American Pulp and Paper Mill Superintendents' Association, Mr. Howard stated that the recovered products and credit items of the process are (1) sulphur and lime for making cooking acid, (2) organic matter for use as boiler fuel, (3) pulp now lost in blow-pit drainage, (4) heat from process effluent recovered as hot water for mill uses, (5) reduced steam consumption in acid plant during winter, (6) less upkeep expense on acid towers, (7) more easily controlled and more uniform cooking acid, (8) probably some economies due to improved pulping action of cooking acid made from the recovered products, and (9) an improved effluent as regards stream pollution. While these credit items have yet to be fully proven by regular operation over an extended period, the plant operation to date gives considerable assurance that all or most of them can be realized.

Thus it appears that the sulphite pulp industry has not only solved a troublesome problem but has made a valuable saving in cost of production. This example should encourage greater activity on the part of other process industries with similar problems.

Commercial Demonstration to Test Power Alcohol Feasibility

By HUGH G. HULL

Chemical Engineer, Niagara Falls, N. Y.
Retiring Editor, "The Iowa Engineer"

After several years of acrimonious controversy the power alcohol question has finally been put where it has always belonged, in a demonstration plant where facts, not oratory, can be accumulated in an effort to learn the truth of the conflicting claims. Whatever their preconceived notions, fairminded chemical engineers will watch the experiment without prejudice. At our request, Mr. Hull has prepared this first published description of the plant at Atchison and has included with it a little of the fuel-blend philosophy that motivates those who see in power alcohol a solution to many of the farmer's troubles.—Editors.

"POWER ALCOHOL," according to certain engineers, "is economically and practically unsound," while others go so far as to scoff at the idea as a complete absurdity. Yet America's first power alcohol plant, recently opened for production at Atchison, Kan., had its rated capacity of 10,000 gal. per day four times oversubscribed by eager customers before the plant was completed. With the operation of this plant we are witnessing what is, for the United States, a new industry —the production of absolute alcohol strictly for motor fuel purposes. Yet it appears that a single plant is helpless more than to scratch the surface of the demand which, almost overnight, has now sprung up for this new product.

No one knows today what power alcohol may eventually mean to the United States. During the years of controversy the proponents of power alcohol have not only not lost but have actually gained in confidence and now have reached the point of testing their contentions on a commercial basis. One plant has been completed and others are being considered in various sections of the Middle West.

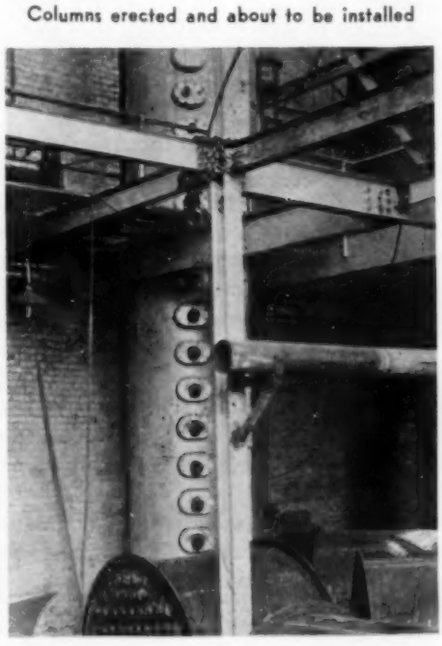
Without delving into the considerations surrounding power alcohol in this country and others, let us glance briefly at the history of the Bailor Manufacturing Co. and its plant at Atchison. In 1933 the Bailor company became interested in the production of alcohol for beverage and industrial purposes. As Kansas was a dry state, a special act of the legislature was necessary to permit erection of such a plant. A small installation was constructed, having a capacity of 2,500 gal. per day, but it did not enjoy the fullest success, largely because of operational difficulties.

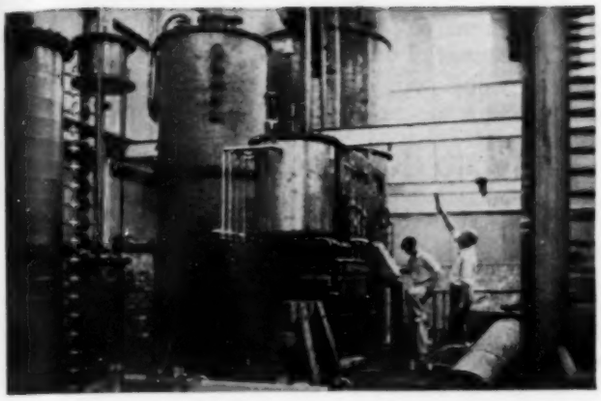
Shortly afterwards, in the early months of 1936, The Chemical Foundation became interested in the commercial production of alcohol for motor fuel purposes, and entered into negotiations with the Bailor company. Since under its charter The Chemical Foundation cannot itself own a plant, it arranged through the medium of a subsidiary, The Chemical Foundation of Kansas Co., connections with Bailor whereby the alcohol would be sold to the Foundation for distribution. It has financed the expansion and remodeling of the old plant, increasing the capacity from the original 2,500 gal. per day to 10,000 gal. per day. The plant is under the direction of Dr. Leo M. Christensen, formally of Iowa State College.

The Chemical Foundation sells the alcohol, which is contracted from the Bailor company on a cost plus basis, exclusively to the motor fuel trade. Requests and orders so far have exceeded the rated capacity of the plant by four times. No purchaser has been allotted the full amount of his order, but an attempt has been made to distribute the alcohol over as much territory as possible, so that the greatest number of people could become familiar with it and its performance. The distribution territory includes Iowa, Kansas, Missouri, Nebraska and South Dakota. The alcohol is being used, of course, in the form of blends with gasoline.

Blending may be done either at the plant or after

Columns erected and about to be installed





Control board and distillation equipment during installation

reaching the dealer. There is at the plant a large outside storage tank for the finished product, which contains about 99.5 per cent alcohol, and there are smaller tanks for the storage of blends or of gasoline. The distribution is largely by means of trucks, considered to be a more generally satisfactory medium of transportation. A truck may call at the plant, if desired, loaded with gasoline, whereupon the necessary quantity of gasoline may be pumped from it into one of the smaller storage tanks and replaced with alcohol. By the time the truck has returned to its destination, the alcohol and gasoline have been thoroughly blended, through diffusion aided by agitation owing to the truck's motion.

Another idea that is being found quite satisfactory is to equip trucks both with gasoline or alcohol containers and with racks to permit carrying corn on the return trip to the plant. In this manner a pay load may be had each way and a little better operating balance is obtained. The raw materials are obtained from the same localities and sections where the sales of the finished product are made. Thus the plant is able to strike a better balance than if it used entirely Kansas and Missouri corn and sold the alcohol over a wide territory; it succeeds better in its effort to prove of tangible aid to agriculture in the sections it serves.

Byproducts to Be Utilized

The commercial success of the plant is not to depend entirely on the principal product, alcohol. In a smaller measure, utilization of the byproducts of the process will do its part. The layout of the plant includes a drying house where the residue from the fermenters is recovered and sold as a high-protein concentrate, good for cattle food. At present the carbon dioxide from the fermenters is being wasted, but later in the year a solid CO_2 installation is being planned for its utilization. It is expected to be installed in time to be in operation for next year's market.

Manufacture of the alcohol itself is quite standard, with standard equipment and reactions used throughout. Occasional deviations are contemplated as new developments or ideas are brought forth experimentally. If these, as a result of research carried out upon them at the plant, are thought to be economical and practical improvements over the older standard process, they will be introduced into the plant. Meanwhile the older equipment and methods will be available to fall back upon if necessary.

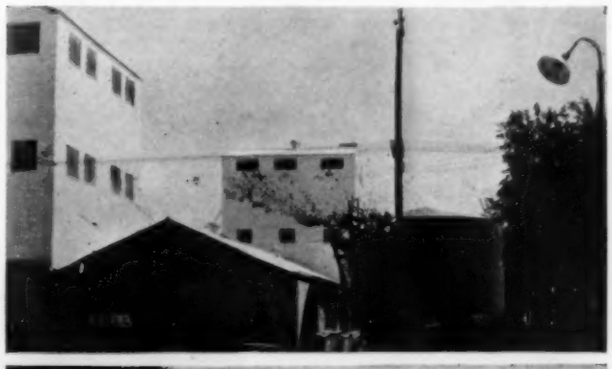
Considerable experimental work is being carried on in the plant, particularly with regard to the dehydration of the commercial 95 per cent alcohol to the final product. Tests are being made with a process under a patent held by Drs. Christensen and William J. Hale, using diethyl ether as the dehydrating agent. The principle of the process consists of reversing, by means of a catalyst, the ordinary reaction for the preparation of ether, $2C_2H_5OH = (C_2H_5)_2O + H_2O$. The advantages of such a process, if it is proved economically satisfactory, are obvious, for the product of the reaction, $(C_2H_5)_2O + H_2O = 2C_2H_5OH$, is simply alcohol itself. By catalytically inducing this reaction in the presence of the 95 per cent alcohol in the dehydrating column, and using for it the water in the alcohol, there would be no impurities to be removed. Furthermore, no reagents would need to be recovered as is the benzene in the present process. This is one of the major directions in which experiments are being made.

Operation Conventional at Present

In the operation of the plant as it is carried on at present, the corn or other carbohydrate raw material is ground in mills and pumped into a large feed hopper. From there it is run into steel cookers, where it is cooked and malted. After the cooking is completed and before the mash is run into the fermenters, the mixture is cooled down to proper temperature by spontaneous evaporation. This is accomplished by pulling a vacuum on the cookers

Bailor plant from the street, showing still and mill buildings and outdoor fermenter tanks

Tanks for absolute alcohol and fuel compounding



themselves, using a barometric condenser for the vapors from the cookers. The desired cooling is simply and efficiently obtained.

At the necessary temperature the mash then passes into steel fermenters where it meets cultures developed separately. The cultures are started in small flasks, then enlarged in small tanks, from which they are run into larger tanks and finally into the fermenters. The Bailor plant has eight fermenters of 25,000 gal. capacity, each, inside the building, and three larger tanks of 110,000 gal. capacity outside. Two of the inside tanks are used only for butyl alcohol. The tanks are so fitted that the intake and discharged valves, the fittings, and the tanks themselves can be flushed out with live steam after each batch, to prevent fouling and souring.

After fermentation is complete the residue is removed and washed, and the washings, together with the liquid from the fermenters, is ready for the still house. The material at this point is known as "beer." The residue is taken to the drying house as was mentioned above, where it is dried to form a high-protein cattle food. Meanwhile, the beer passes first to the beer still, where much of the water and impurities is removed, and the solution is made ready for the alcohol columns. The heat supply for this still, as well as for the others in the still house, is provided by exhaust steam from the engine house, at a pressure of 15 lb. gage. The alcohol columns are standard rectifying column stills, which give as product commercial 95 per cent alcohol, quite pure with the exception of the water remaining in it.

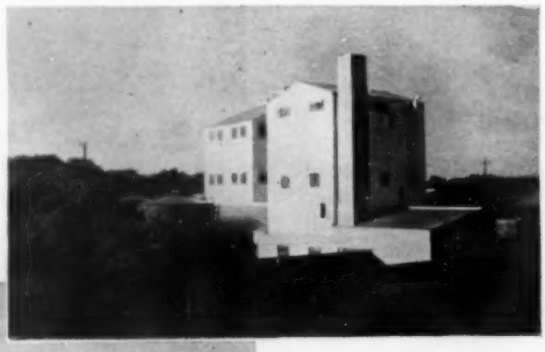
The alcohol then passes to the anhydrous column where it is further dehydrated, using an azeotropic process. The water-alcohol solution is fed into the column, and benzene is added from a small benzene feed tank above. The benzene, water and a certain proportion of alcohol join to form a low-boiling-point mixture which passes out at the top of the column. In this way the water and benzene are removed, leaving absolute alcohol to be drawn off at the bottom of the column.

The benzene and alcohol in the low-boiling, three-phase mixture are not recovered in a completely pure state. The mixture passes through a dephlegmator and is condensed and run into a decanter or separator. The liquid in the separator forms two layers, the upper of which contains most of the benzene. This layer is run back into the benzene feed tank for the anhydrous column, in spite of the presence of small quantities of water and alcohol. The lower layer is sent to a benzene recovery column where it is fractionated. In this column, too, the low-boiling mixture passes off at the top of the column and is sent to the separator. The alcohol concentrate from the lower part of the column returns to the anhydrous column to be mixed with the 95 per cent alcohol fed to it.

We have now reached the point where absolute alcohol is obtained from the anhydrous column, and is ready for denaturing. The manufacture of ethyl alcohol must, of course, be under Federal supervision, and the product, unless it is intended for beverage purposes, must be effectively denatured according to Federal requirements. Denaturing the alcohol has been one of the thorns in the side of the power alcohol forces. A denaturant must be found that is economical, and that means if possible one costing no more than the alcohol; it must be effective, so that it cannot be separated from the alcohol; and it must be as good as alcohol itself as a fuel. After settling upon the complete denaturant known officially as "C. D. 10" the new plant ran up against another difficulty when a method was disclosed by which the denaturant could be completely and rather easily removed from the alcohol. The Government withdrew its approval and the plant sought another denaturant. Happily, Federal approval was obtained of a denaturing formula developed previously by Dr. Christensen and one which proved economically and practically superior to those formerly considered.

At right, general view of plant from the rear

Below, catwalk and outdoor fermenter tanks



The plant, completed and in full operation, will employ directly in it about 40 men after the installation of the solid CO_2 unit for the recovery of the carbon dioxide. It will furnish, directly and indirectly, employment for about 2,000 men, in various phases of operation, delivery, production, and so on. Raw material to the extent of 4,000 bu. of corn per day or its equivalent in carbohydrates of other raw materials will be consumed, with the plant operating 24 hours a day.

It will be interesting in the ensuing years, both to opponents and to exponents of the idea of power alcohol, to follow the development and success of this first major American venture into that field. Its start has been auspicious, with its production capacity so far oversubscribed, even before the plant was in operation. If the demand continues, and grows accordingly, prospects will be bright indeed for further expansion in the use of alcohol in motor fuel.

Dr. Compton with H. L. Derby, William B. Bell and E. M. Allen at the annual meeting of the Association, at Absecon, N. J.

DR. KARL T. COMPTON

WARNS THE MANUFACTURING CHEMISTS' ASSOCIATION OF

DANGERS Of Regimentation and Complacency

IF I WERE SPEAKING to a less progressive group, I would probably take this opportunity to urge more active interest in research. With you that is unnecessary, so I shall speak rather about two conditions which seem to me to threaten this progressive work of science which has meant so much to the material prosperity of our country, and indirectly also to its social and spiritual welfare, and which will inevitably become more important in the future as populations grow and natural resources shrink. One of these threats is the philosophy of regimentation and the other is complacency.

There is evidence from many sides of a conflict in this country between two radically different philosophies of social progress. These two philosophies permeate our industrial, economic and political life in many aspects. You of the chemical industry are exponents of one of these philosophies; in fact your very industry has grown out of it and your future will depend on it. This philosophy may be described as faith in the desirability of knowledge and skill. According to it knowledge is power; power gives opportunity; mankind has responsibility and capacity to use the opportunities created by knowledge and skill for its betterment. But perhaps the philosophy can best be understood by reference to such examples as the following.

The role which science has played in social progress was set forth in the preamble to resolutions adopted by the American Association for the Advancement of Science, and submitted to the President of the United States in 1934:

"WHEREAS, Development and application of science have been basic to the economic and social progress of nations, making possible such movements as universal education, abolition of child labor and slavery, emancipation of women, insurance and pensions, moderate hours of labor and great improvement in the standards of health, comfort and satisfaction in living; and

"WHEREAS, Scientific developments have not only conferred general benefits, but in particular have been largely effective in leading to recovery from previous depressions—as the railroad industry following the depression of 1870, the electric industry following that of 1896 and the automobile industry following that of 1907; and

"WHEREAS, Scientific research is a productive investment proven by experience to yield a high rate of return, as illustrated by the saving of $2,000,000,000 per year from the Bessemer steel process and of over $1,000,000 per day from the modern incandescent lamp, and as illustrated also by the entire chemical, electrical, communication, transportation and metallurgical industries and by the enormous employment in such industries;—."

It is this same faith which is driving the Chemical Foundation and the Farm Chemurgic Council to seek through science rather than through artificial restrictions and regulations a positive and constructive approach to a solution of the economic difficulties of the farmer, by developing new and useful industrial outlets for his products.

It was this same faith, accompanied by a word of warning, which led Herbert Hoover, while Secretary of Commerce, to point out the fact that our country was in danger of falling behind in its industrial progress through failure adequately to support the oft-termed "useless research" in pure science out of which the industrial developments of the future must grow.

The adherents to this faith reckon research as an investment. This was expressed by Dr. Robert A. Millikan when he said, "Research pays because you know what

Based on an address on the Dangers of Regimentation and Complacency by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology before the annual meeting of the Manufacturing Chemists' Association, Absecon, N. J., June 4, 1936.

you want, go after it with informed brains and in general get it; but it often yields (extra) dividends because you get something that you didn't go after."

These illustrations are typical of that philosophy which has faith in knowledge and courage to face the opportunities and responsibilities which knowledge provides. It takes little observation, however, to disclose the fact that this faith is not ingrained in the thought and actions of many people in responsible positions. By way of contrast, therefore, let me give the following examples taken from our experience during this depression, when, if ever, it has been important to call on all resources, including science, which make for economic welfare and social progress.

Science in Governmental Policies

The federal government has assumed the responsibility for leading the country out of the depression and into the more abundant life. It has set in motion some movements which I believe will work out in the public benefit, and I should not wish the following remarks to be interpreted either as wholesale condemnation of the recent governmental policies or as indicating that I believe science to be by any means a universal panacea. There is undoubtedly enormous room for improvement in such matters as monetary policy, industrial and labor relations, care for the unfortunate, etc., which are not primarily problems for the natural sciences, though even in these fields the effects of science may predominate basically. But what I would call to your attention is the almost total disregard of science in the policies of the government, even in the face of illustrations like those quoted above, which show what science can do if given a chance. Let me give several examples.

As a move toward balancing its budget about three years ago the government greatly curtailed the appropriations for its scientific bureaus by amounts of the order of 50 per cent, thus throwing many hundreds of scientists out of employment. In fact, the scientific bureaus were the most severely curtailed of any of the government services. Yet at the same time there was provided vast emergency employment, most of whose results are of relatively far less ultimate value to the public than the work which was discontinued. And in some cases at least, higher wages were paid for this emergency work than for the scientific work that was discontinued.

When the government appropriated more than $3,000,000,000 to give emergency employment in public works construction and subsequently in other fields, it would have seemed wise to follow the precedent which private industry in all fields has found advantageous, namely, to use some small portion of this fund, (which in progressive private industries would run to several per cent of the total), for scientific and engineering studies looking toward the development of better public works in the future. A proposal with a program to accomplish this was prepared with the cooperation of officers of some 35 of the leading engineering and scientific societies of the United States, and submitted in September 1933 to the Public Works Administrator. He received the proposal sympathetically but disposed of it with the words (approximately), "I am 99 per cent convinced that this program ought to be carried out, but unfortunately I am 100 per cent convinced that there is no provision under the law which appropriated the funds whereby it can be done." The matter was then referred to the President, but nothing came of it.

Then later, in 1934, the Science Advisory Board presented to the President "A National Program for Putting Science to Work for the National Welfare," which included a permanent plan for providing the government with more adequate advice on scientific matters and a temporary plan for preparing a detailed program of scientific work on problems of great public importance and of a type which neither private initiative nor existing government bureaus can be expected adequately to handle. This program was referred by the President to certain of his non-scientific advisers and parts of it seemed to arouse a little interest, but not enough to lead any one in authority to do anything about it.

These and similar illustrations of the attitude of high government officials form a sharp contrast to the policies of progressive industrial groups, such as chemicals, communications, automobiles, motion picture, metals, etc. I have puzzled a good deal over this contrast and was at first inclined to believe that it might be explained by the fact that science is not sufficiently understood or tangible to give to a scientific program any strong political appeal. Roads, dams, canals, or building projects are immediately tangible, produce immediate results and are easily understood, but it takes a higher type of imagination and also a higher standard of group civilization to become equally interested or enthusiastic about activities which can only be expected to show unpredicted results in the somewhat indefinite future. I think there may be some truth in this explanation of the evident lack of interest of most politicians in scientific work, but I do not believe that it is the basic explanation, since the present administration has had ample power and public support to include in its plans a positive constructive program in science, directed to public benefit generally and also to stimulation of industry, if the administration had really been interested in or convinced of the value of such a program.

Science Ahead of Rest of World

I am consequently driven to the conclusion that the administration's attitude toward science is at least *not* motivated by the philosophy of faith in the ultimate value of science, but is influenced rather by the conflicting philosophy which was suggested rather whimsically by the Bishop of Ripon at the 1927 meeting of the British Association for Advancement of Science, when he advocated a ten-year holiday for science in order that the ordinary man might catch up. To all those who are timid, or fearful to face the responsibility of the opportunities created by science, or unable to understand science, or pleased at the opportunity to throw on science the blame for all manner of troubles, or jealous of the rapid strides of science,—to all of these groups this remark by the Bishop of Ripon offers a retreat and rallying point. Out of it has grown a philosophy of anti-science, sometimes aggressive and sometimes only doubtful. It gave social planners and reformers such a basis of attack as: "The scientists have run the world into confusion and ruin; hold them back, put them

under our control, give us the reins, and we will bring back order and a more abundant life by social planning."

Certain it is that among the social advisers close to the administration are those who for years have been advocating a policy whereby developments in the natural sciences should be brought under the control and supervision of the social scientists, in order that our civilization might progress along the lines of a campaign planned by them.

Like most movements, this one has its elements of value but it went to extremes which people are now coming to realize. The worst features, in my opinion, were the naive reliance on rules and regulations, even in matters whose success or failure were absolutely dependent on scientific knowledge and skill, and the failure to realize that only stagnation, and failure in competition with more progressive foreign nations can come from a policy which stifles rather than encourages the initiative and the progressive search for knowledge which are the basic elements of science.

Overemphasis of Social Angle

It is of course true that not all who are influenced by this philosophy go to these extremes, but I am certain that in various degrees it has a marked influence in determining the interests and actions of many policy-making groups. This is likely to be far more emphasized in government circles than in industrial circles because, while industrial circles contain a large representation of men with scientific understanding and technical training, such men are almost wholly absent from government circles. Is it any wonder, therefore, that there is difficulty in convincing important government officials of the value of an aggressive, sustained, scientific program?

In retrospect it is interesting and somewhat pathetic to see the way in which the values of scientific work are often realized too late. For example, the program for readjusting the submarginal lands of extreme agricultural risk is thoroughly sound from an economic and social point of view, and it is to the credit of the present administration that it is attempting to make headway with this problem. In doing so, however, it becomes immediately obvious that there do not exist the scientific criteria with which to define different degrees of agricultural risk in anything like adequate extent to put a wise policy into effect. Scientific information could only have come from scientific studies of soil, climate and social factors extending over many years. By the time the need of these studies is forcibly apparent there is also a realization that they should have been begun years ago.

When the government desired to stimulate new, preferably non-competitive, industries and it particularly attempted to discover such industries which might be located in the experimental subsistence homestead regions, it became evident that new industries cannot be created by wishful thinking, however much money may be available, but only by research, discovery and development in a sustained program. And yet the very government which has been hampered in its social planning efforts through lack of scientific data, has refused to include the rapid completion of the topographical survey and mapping of the country as one of its emergency work projects!

Thus I think we are driven back on science to provide the materials not only for industrial development and new employment under private initiative, but also for any movement which may be attempted in the direction of a federally planned economy. We are also driven, I believe, to the conclusion that knowledge of nature by and large is of basic importance to our welfare, that its discovery should be encouraged even when its practical application is not in sight, and that if science were really put to work for the country as a whole on a scale comparable with its importance in the chemical industries, we would find in it the greatest investment and insurance for future welfare.

The conflict between these two philosophies goes far deeper than the question of the values of science. It is inherently the conflict between individual opportunity and regimentation. We find it in all stages and occupations of life.

We have an outstanding example of the conflict between these two philosophies in the matter of handling unemployment relief. The one group which emphasizes individual opportunity and responsibility would place this relief largely in the hands of the individual states, while the other group would regiment this relief by centralized administration for the country as a whole, which has led, I believe, to an unnecessarily large penalization of certain portions of the country to subsidize others, to inefficient administration, and to a "grab-bag" attitude which is most unfortunate.

We must admit that each of these two philosophies is logical and perhaps feasible of operation. I confess to great sympathy with the ideal of a planned social economy in which the social elements are coordinated and developed in such manner as to bring greatest benefit to the social group as a whole. I believe, however, that past history and recent experience both demonstrate the fact that no individual or group is anywhere nearly wise enough to so manipulate the complex elements in the social pattern as to form them into this ideal picture. As a practical working basis it remains true that those elements of individual initiative which include the search for truth without restrictions and with faith that man's capacity to utilize the opportunities thus created is sufficient to insure their general benefit, forms the best practicable basic approach to improving social welfare, and artificial regulations should be decidedly secondary.

Put Science to Work

I would liken those who are unsympathetic with the progress of science to that wicked and slothful servant in the Bible who wrapped his master's talent in a napkin and buried it in the ground. The master had the right to expect that his servants would put all of their talents into useful and productive activity. One of the talents, which we have to work with in handling our immediate problems and in laying the foundation for the future, is science. It should not be buried but should be put to work as actively and productively as possible. We should be deterred neither by the fact that this talent may earn larger dividends than some of the other talents nor through timidity lest these dividends may not be used wisely.

The other danger which I see as threatening even a progressive industry like yours is the danger of com-

placency. The results of succumbing to this danger were graphically described by Dr. Charles F. Kettering in an article in a recent issue of the *Saturday Evening Post*. It is psychologically the same danger which threatens any individual or organization which has attained a comfortable and apparently safe position. To allow this complacency, however, to undercut continued active efforts toward progress is the first step to certain stagnation.

It is perhaps dangerous to quote examples because these may be misunderstood and the story which they tell may not be complete, but I think that the following examples will be sufficiently clear to illustrate the point. The lumber industry has been and remains one of the great industries of the United States. It is now in a less prosperous condition than it was formerly. While there has been progress within this industry in increasing the efficiency of cutting, promoting reforestation, speeding up seasoning, treating the wood for protection against fire and decay, and attempts to develop new sales and construction outlets, it is certainly true that by and large the industry has not made a serious attempt to improve its methods or its product to an extent remotely comparable with those other industries which we recognize as technically most progressive. It has only been with the pinch of competition with other building materials that serious thought has been given to this question. I do not know just what beneficial effects a really significant scientific program in the lumber industry might have produced, but I do know that many other industries of comparable magnitude would never have come to their present importance without such a program.

Evidences of Complacency

In the railroad industry we find another interesting example. In its pioneer days of initial technical development and rapid building it was perhaps the most vigorous and forward-looking of all American industries. It grew to the point at which it practically controlled the internal transportation of the United States, and in this situation its pioneering spirit flagged. Its monopoly encouraged a certain degree of "public be damned" policy, and it has suffered first, through the public's taking over an increasing amount of regulation and second, through the competition of other transportation media which it itself might well have developed had its basic motivation been service to the public. There are many in this industry who are now urging a more active research program. A good deal has been done recently under the spur of competition to improve railroad transportation facilities. The railroads deserve some credit for this improvement but not as much as is sometimes claimed, because by and large these improvements have been developed independently of the railroads and simply taken over and adapted to railroad use. This applies to air conditioning, diesel and electric traction, improved steel and signalling devices, and the basic scientific and technical work which has improved the efficiency of steam engines. Had the railroads throughout their history devoted funds to research and employed technically trained men to an extent comparable with the chemical, electrical, automotive, or air transport industries, and done this with the prime objective of providing the public with the best possible service in the field of transportation, it is certain that their situation would now be far more satisfactory. Let us hope that the efforts which are now being made within this industry to develop a more forward-looking research program, even at this late date, may be successful. The recent experience of several European railroad systems in this matter is highly encouraging.

In my judgment the great steel industry has also erred in this direction, particularly during its period of greatest monopoly. In general it has not been the group which has developed the most useful new products in the way of important alloys and methods of physical treatment to provide improved qualities for special services. It had originally the most favorable opportunity to make these developments, but I believe that confidence in its apparently strong position led to failure adequately to utilize them. Fortunately this industry is beginning to realize the situation before it is too late and at last report had some 2500 employees engaged in research with an expenditure of about $9,000,000 during the current year.

As the other side to this picture, most of the industries which are most active in research are those which are highly competitive, such as radio, automobile, electric manufacturing and chemical. (Though this it not universally true, as shown for example by the textile industry until recently). As long as keen competition exists, complacency and overconfidence are minimized and there is the greatest possible urge to utilize the resources of science and to operate the business in such manner as to give the most acceptable service to the public. Sometimes the danger of complacency in a monopoly has been avoided. An outstanding example is found in the history up to date of the Bell Telephone system which has maintained an extraordinary program of research and development and has made its cardinal principle the best possible service to the public. It seems to me that by far the greatest merit in the Sherman Anti-Trust Law is not in the element of protecting the public against exploitation, but rather in protecting the public and the industry itself against the dangers, in monopoly, of that complacency which leads to stagnation and failure to maintain that progressive attitude which should lead continually to ever-improving service to the public and thereby maintenance of the healthy condition of the industry itself.

For reasons such as these government monopoly or extensive government control would be the greatest of all possible disasters to this country. All the dangers inherent in an industrial monopoly are raised to the *n*th degree in a government monopoly, for this represents the maximum protection against competition and the minimum inducement to continual progressive policies.

To summarize these remarks, therefore, I would simply say that those of us who see in past experience the benefits of science and private initiative must do what we can to promote them in the interests of our future national welfare. We should oppose, through education and example, the philosophies of defeatism and regimentation which aim at raising the social status of mankind by neglecting or suppressing those agencies which are contributing most effectively toward this uplift. We should avoid the internal dangers of complacency; and I believe that the safest formula for so doing is for every organization to adopt the fundamental policy of carrying on in such manner as to give the best possible service to the public.

Many modifications of 18–8 stainless steel are in general use throughout the process industries

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New Materials Prolong Life Of Equipment

GREAT IMPETUS has been given in recent years to the development of new materials of construction for chemical engineering equipment. This has been due primarily to the success of the chrome and chrome-nickel steels. However, the movement has not been confined to metallic materials but has included every type in use. The movement is still growing and as a result many modifications and improvements have been made recently. Some of the most significant are discussed here in order to inform the engineer regarding the materials now at his disposal.

The alloy with 16–18 per cent chromium and under 0.10–0.12 per cent carbon is one of the most useful of the stainless steel group. It has excellent resistance to corrosion, is reasonable in cost, and from the standpoint of general utility may be regarded as the best of the straight chromium alloys. The addition of copper is useful in increasing resistance to salt under water and to non-oxidizing acids.[1] A low-carbon alloy containing approximately 16 per cent chromium and 1 per cent nickel has recently been produced in America. It has an ultimate strength of at least 190,000 lb. per sq. in. and not less than 6 per cent elongation in strips 0.015 in. thick or more. In small amounts, molybdenum noticeably increases the resistance of this alloy to dilute mineral and to organic acids.

The 4–6 per cent chromium steels have one important application as pressure still tubes in petroleum refineries. Experience has proved that this alloy steel resists corrosion where the corrosive medium contains hydrogen sulphide or any sulphides which react with iron, steel, brass, or Monel metal, giving iron sulphide, copper sulphide, or nickel sulphide as the products of corrosion. When used at temperatures between 800 and 1,200 deg. F., creep and short-time ultimate strength of this steel are greater than that for carbon steel. Although this type of low-chromium steel has been largely used in the form of tubes, some plate stock has been fabricated into equipment for conveying high-temperature gases around recuperators in refineries. Addition of titanium or molybdenum to the 4–6 per cent chromium steel improves the resistance to corrosion and scaling, thus making it more useful for air preheaters, super-heater tubes, heat exchangers, and so on.

A 2 per cent chromium, low-silicon steel has just been announced, but experience is limited to a few test pieces and therefore much has still to be learned about its practical uses. It was developed to meet the need for an economical steel for applications requiring reasonable resistance both to corrosion and to oxidation. The tensile properties of the annealed steel are practically unchanged by long heating under stress at temperatures up to 1,200 deg. F. Tests indicate that the steel is at least half as corrosion-resistant as the 4–6 per cent chromium-molybdenum steel, while in some liquid and vapor phase applications the rate of corrosion is nearly as low as that of the better known low-chromium alloy; further, it is said

[1] Based on a paper, entitled Metals and Alloys Used in the Construction f Chemical Plant, resented before the Chemical Engineering Congress of the World Power Conference, London, England, June 23, 1936.

that the oxidation resistance at temperatures up to 1,500 deg. F. is almost as good.

In 1912, F. M. Becket commenced work on the addition of manganese to steels, particularly to develop acid-resisting compositions; some years ago, he discussed[5] the effects of appreciable quantities of manganese on the properties of steels over a wide range of chromium. Manganese considerably changes the physical properties of the 17–19 per cent chromium steels, increasing strength and toughness. Relatively small additions of copper to these steels have decidedly beneficial effects.

The iron alloy of 18–19 per cent chromium, 8–10 per cent manganese, 0.7–1.2 per cent copper, and low carbon is not completely austenitic and is not quite so resistant to as many chemicals as the 18–8 chromium-nickel steels. At high temperatures, the chromium-manganese-copper steel has neither the strength nor the high creep of the chromium-nickel steels, although it has certain important advantages. Among these is the relatively low loss of ductility during exposure for long periods at the higher temperatures, 1,475 to 1,650 deg. F. It will withstand atmospheric corrosion about as well as the 18–8 alloy and is more resistant to the attack of sulphur and sulphur gases at high temperatures.

Addition of nickel to the chromium-manganese-copper steels improves their resistance to a large number of corroding media. Because of their superior ductility and softness, these steels are excellent for deep drawing and other drastic cold working operations. Production of an 18–19 per cent chromium, 5–5.5 per cent manganese, 4–4.5 per cent nickel, 0.7–1.2 per cent copper, and 0.10 per cent or less carbon steel is developing in Europe, especially in Germany.

The addition of nitrogen to chromium and chromium-nickel steels[9] is attracting attention. The nitrogen, which is believed to be in combination with chromium as nitride, inhibits grain growth and improves the strength and ductility of the material. The optimum nitrogen content,[6] varies with the amount of chromium present; for 12–14 per cent chromium steels it should be 0.06–0.10 per cent. From 0.15 to 0.25 per cent nitrogen produces in 20–25 per cent chromium steels improved toughness and remarkable resistance to deterioration through marked grain growth at elevated temperatures. With high-chromium alloy castings, a product is obtained that withstands abuse without cracking, suggesting among others its use in pump impeller parts having great differences in cross section.

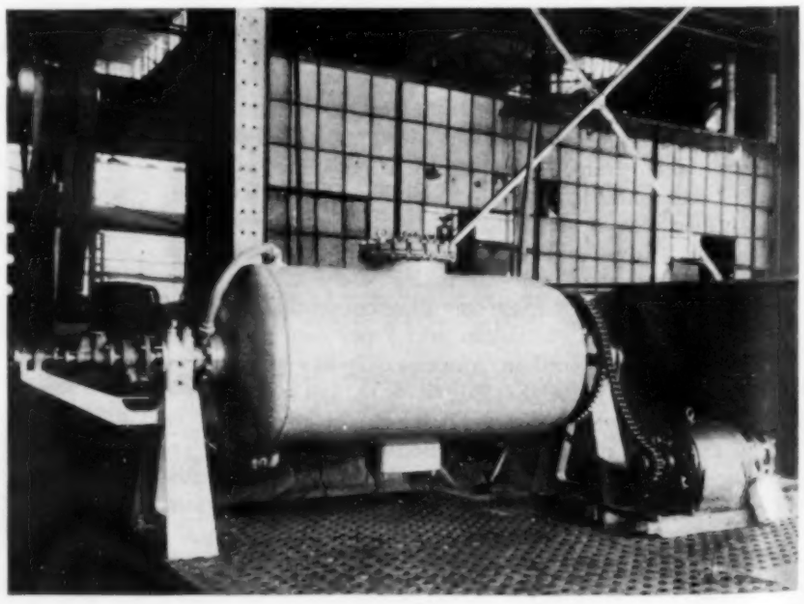
The introduction of nitrogen to chromium-nickel steels improves machinability and provides non-magnetic castings of relatively high strength. Little difficulty is met in welding steels containing nitrogen, and these improvements in mechanical properties are not obtained by the sacrifice of corrosion resistance.

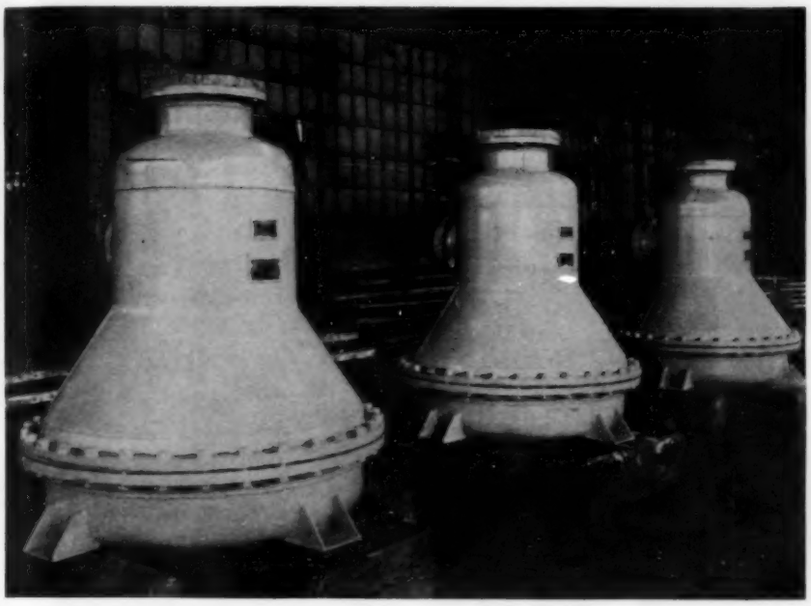
The addition of titanium and columbium to the plain chromium steels,[4] modifies the action of the carbon and thereby effects some interesting improvements. In steels containing less than about 12 per cent chromium, an appropriate addition of either of these agents augments the resistance to oxidation at high temperatures and minimizes tendencies to air hardening. While plain low-carbon 18 per cent chromium steels render excellent service in numerous applications, increased softness and amenability to deep-drawing operations are greatly needed, particularly by the fabricator, and the addition of titanium or columbium to this steel assists considerably in this direction.

To meet industrial demands for metallic materials possessing a wide variety of mechanical and chemical properties, metallurgists have developed many modifications of the 18–8 alloy. One of the earliest and most useful of the modifications contains from 2 to 4 per cent molybdenum. It possesses increased corrosion resistance. One of the largest users of this material is the pulp and paper industry, which has adopted a specification calling for a minimum of 20 per cent chromium, 9 per cent nickel, carbon not more than 1/100 of the chromium, and 2 to 4 per cent molybdenum, for a casting to handle sulphite liquors. The molybdenum is optional, although generally demanded. Other process industries have adopted the molybdenum modification for many applications.

Silicon improves the welding qualities of 18–8 alloys and when present in sufficient amount strongly inhibits the susceptibility to intergranular corrosion, as shown by Payson.[12] It has very little influence upon the high-temperature characteristics either in short time or creep tests. The late J. A. Mathews stated that, contrary to general belief, silicon does not produce brittleness; in fact, under certain conditions the opposite is true, according to him. As for its effect on corrosion resistance in general, silicon exerts but slight influence on the 18–8 alloys.

Lead-lined steel extractor for production of sulphur dioxide





Lead-lined steam separator for chemical plant in interior of China

Reference to the early work of Becket,[5] on the addition of manganese and copper to the stainless steels, has already been made. He found that such modified steels had certain excellent mechanical and corrosion-resistant properties.

Armstrong[13] has produced an alloy that does not require a relatively-high final heat-treatment to make it fully corrosion-resistant. The alloy is an 18–8 with additions of copper and manganese, usually 2.9 per cent of the former and 4–6 per cent of the latter. The strongest points in its favor are resistance to solutions of sulphuric acid and to intergranular corrosion. For special purposes the manganese can be varied between 1.5 and 12 per cent, and the copper from 1.5 to 3 per cent. The higher manganese, up to 12 per cent, increases the resistance of the alloy to sulphuric acid solutions, but lowers the resistance to other chemicals and also increases the melting cost.

One of the few weaknesses of the 18–8 type of alloy is its susceptibility to intergranular corrosion. This is apt to occur near welds if the metal is not heat-treated after the operation, but when the equipment is very large it is not practicable to give it such a treatment. Metallurgists are endeavoring to eliminate this unfortunate tendency in the 18–8 alloys by slight modifications in the chemical composition.

Titanium was suggested by Houdremont and modified by Bain, Aborn, and Rutherford to overcome this difficulty. The amount of this element required depends upon the carbon content; a sufficient proportion must be present, experimentally determined as six times the carbon content in excess of 0.02 per cent, although Mathews has reported that some specimens with a lower ratio have been found commercially immune after welding.

Another addition to steels of the 18 per cent chromium-8 per cent nickel type in order to retard intergranular corrosion is the metal columbium. Becket and Franks[4] have shown that the addition of columbium to these austenitic steels when exposed concurrently to elevated temperatures and chemical action led to exceedingly satisfactory results. It has been observed that the presence of approximately four times as much columbium as carbon diminished the range of temperature through which these steels were attacked at the grain boundaries. When the ratio of columbium to carbon was increased to about seven to one, a marked improvement was obtained, although it was still possible to disintegrate the steel after holding a long time in the most "sensitizing" (about 1,020 deg. F.) temperature. Further increase of columbium to at least 10 times the carbon yielded steels that failed to disintegrate after exposure for either long or short periods at all the temperatures between 570 and 1,560 deg. F. Columbium is not required in excess of 5–6 times the carbon content when the fabricated structure is not to be employed at high temperatures after welding. Moreover, columbium does not impair the excellent corrosion resistance of these stainless steels.

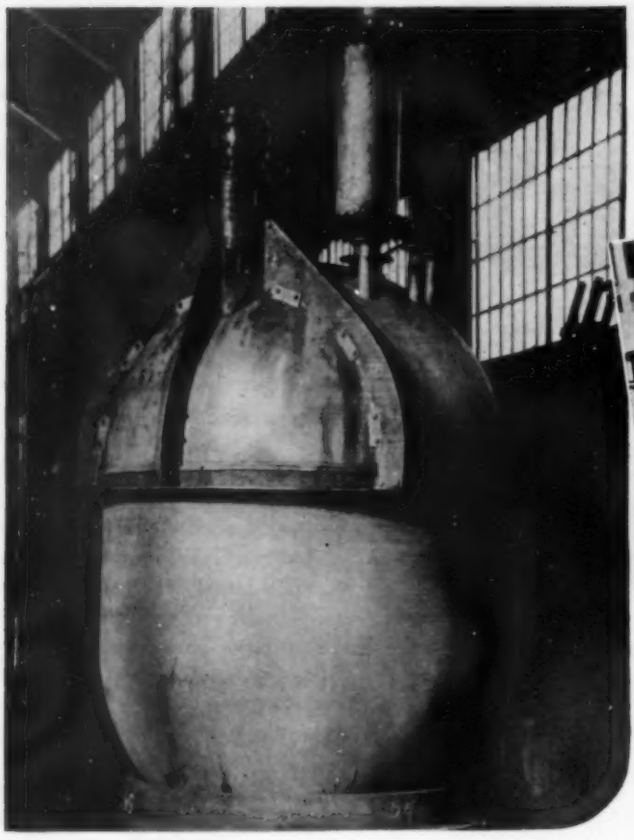
Nitrogen has been found to improve certain properties of the austenitic chrome-nickel steels as well as the plain chromium steels. Franks reports that nitrogen imparts strength to castings of the chromium-nickel steels without appreciably lowering the ductility or toughness. It also improves the machinability and provides non-magnetic castings having relatively high strength.

Of the nickel-copper alloys, undoubtedly the most important commercially is Monel metal. It contains approximately ⅔ nickel and ⅓ copper, and in addition small quantities of iron, manganese, and silicon added for specific purposes. Under most conditions, resistance to corrosion increases with the nickel content of the alloys, at least up to 80 per cent nickel. It seems safe to say that Monel metal possesses a useful degree of resistance towards more corrosives than most other materials of construction. However, its high strength, good ductility, and ease of fabrication are of equal practical importance, since they permit its use where corrosion resistance alone would not suffice. They often determine its choice in preference to other materials of equivalent corrosion resistance but of inferior mechanical properties.

A modification of this alloy contains 3.45 per cent aluminum. It has proved to be the best composition that will retain the excellent corrosion resistance that is characteristic of Monel metal with the added advantage of increased strength and hardness after heat treatment.

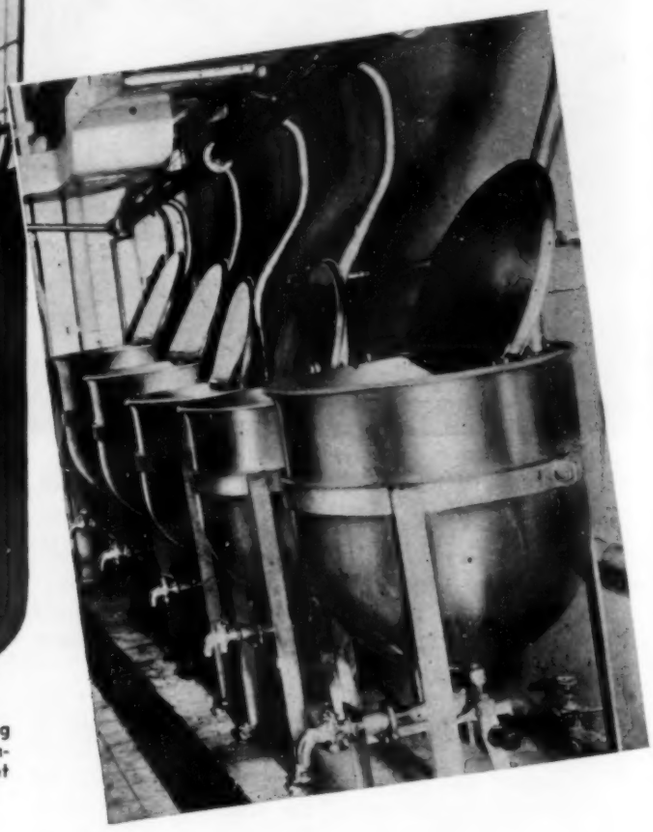
Copper and its alloys, brass and bronze, have many important uses in the chemical industry. Demand for these materials from the brewing industry alone, since its revival in the United States two or three years ago, has been enormous.

Deoxidized copper results from the deoxidation of electrolytic metal, containing a minimum of 99.9 per cent copper by the addition of phosphorus or some other agent.



Pressure equipment for handling hydrochloric acid made almost entirely from Hastelloy welded sheet and machined castings

Many modifications of 18–8 stainless steel are in general use throughout the process industries



The mechanical properties and thermal conductivity of the metal are not impaired by the process, provided the added agent is kept to a small percentage. Tubes of this material are extensively used in equipment such as heaters, coolers and evaporators.

Chromium is used in copper for its contribution of strength and hardness to the resulting alloy. This metal in amounts up to about 2 per cent dissolves in the copper at elevated temperatures. Williams[14] states that later it precipitates from the solid solution by heat treatment of the solid metal and does not decrease the conductivity to a sufficiently large degree to overcome the initial advantage conferred by the conductivity of the copper. The availability of such copper alloys provides a useful tool where the drainage of heat away from or the conduction of heat to substances is useful. Another new and related development is the silver-bearing copper alloy.

In 1932, a new alloy of beryllium and copper having unusual properties was announced. Although its uses are limited, its non-sparking property, strength, and resistance to wear and corrosion make possible the use of this material for hammers and blades in grinding mills, pulpers and mixers. Hand tools such as chisels, hammers, scrapers and wrenches are made of beryllium-copper for use in explosive atmospheres.

A year ago Crampton and Croft[21] presented interesting data on the copper-nickel-aluminum alloys. The alloy of 92 per cent copper, 4 per cent nickel and 4 per cent aluminum is indicated as one of the best in this class. It has excellent resistance to the impingment type of attack in condenser tubes. Its unusual resistance to sulphur attack results in considerable application for condenser and heat exchanger tubes in petroleum refineries.

Until very recently there were only two important types of lead used in the chemical industry in the United States—chemical lead and hard lead. Tellurium lead,[27] which contains only a very small amount of the alloying material, is a new development that was brought over from England two or three years ago. Chemical lead, which gained the name from its wide use in this industry, is practically pure except for a small quantity of copper 0.05–0.08 per cent).

Tellurium lead has greater tensile strength and more resistance to fatigue and corrosion than other chemical leads.[25] Rather brief experience of it in America indicates that for a short period this lead alloy will withstand boiling sulphuric acid and that it very satisfactorily resists phosphoric acid, chlorine gas, impure solutions of sodium sulphite, and sulphur dioxide.

This alloy of lead has the unusual characteristic of toughening when strained. The tensile strength and resistance to fracture can be improved by working; and

although work-hardened tellurium lead is harder than chemical lead, it is not brittle. A sheet can be bent and hammered at a bend without fracture. The importance of a metal which strengthens under strain is obvious, especially when utilized in equipment such as agitator tanks where vibration stresses are encountered, and at high temperatures there should be less tendency to sag, buckle, and crawl, with less possibility of fracture after prolonged service.

Lead-covered copper pipes and lead-lined steel vessels with adherent coverings of substantial thickness are being successfully used in many plants. The homogeneous coating of lead is fused to the steel or copper. A process for coating or lining steel equipment by wiping has recently been described by Greger.[28] The steel is pickled and tinned and a coating 1/10 mm. thick is applied. Such linings are stronger than the loose coverings, have the advantage of offering better heat-transfer and tend to eliminate troubles due to thermal changes or vibration. While initial costs of such equipment are higher, it may be noted that vacuum may be used in the apparatus without damage to the linings. According to Greger, the equipment can easily be repaired when worn.

The commercially available aluminum alloys cover a wide range of composition and of physical properties. They range from high-purity aluminum, containing not less than 99.8 per cent of the metal, through a series of alloys with greater or less proportions of various alloying elements. These alloys may, by appropriate heat-treatment, be given physical characteristics covering a wide range.

Much work is being done on the development of suitable solders for aluminum and aluminum alloys, as shown by the large numbers of patents issued on the subject. Zinc-base hard solders or mixtures of zinc, aluminum, and tin are finding considerable popularity for this purpose. Lower melting solders are constantly being sought, but are usually unsatisfactory because of the inability to use an effective flux at comparatively low temperatures.

Precious clad metals and plated surfaces are new developments that no doubt will be utilized by chemical engineers in the immediate future. Recent improvements have been made in plating platinum, rhodium, and palladium. At the 1935 Chemical Exposition in New York, gold, silver, platinum and other precious metals clad on nickel, brass, copper, and steel base metals were exhibited for the first time. Layers of precious and base metal are fused together and rolled or drawn to finished dimensions. The surface is hard, dense, even in veneers as in the use of gold of less than 0.001 in., although the usual ratio of precious to base metal is 1 to 10.

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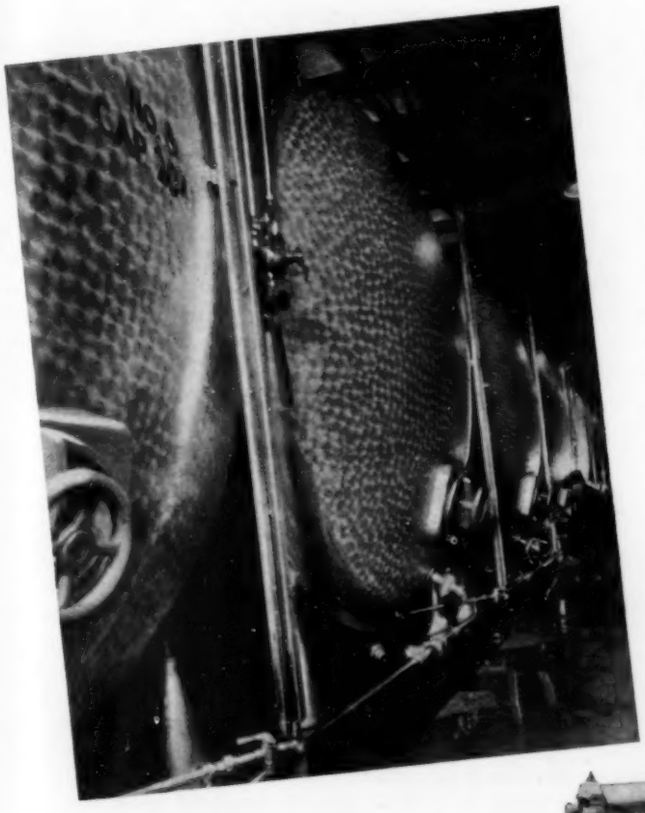

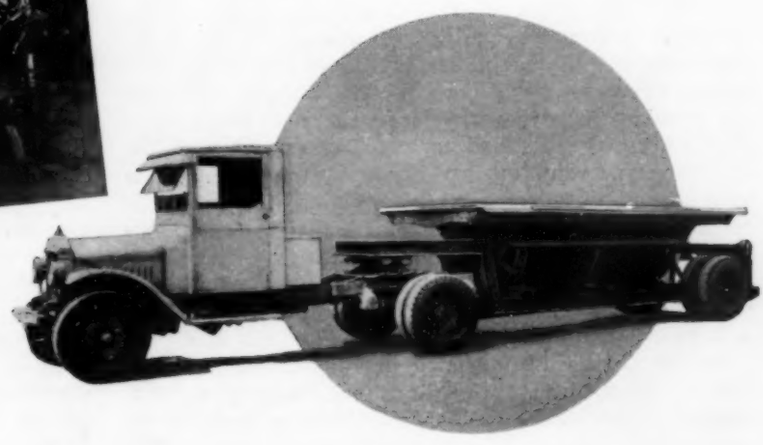

Above — Aluminum horizontal government storage tanks, each of 204 bbl. capacity, in use in a Pennsylvania plant. Right—Body of truck is fabricated from a modified 18-8 stainless steel. Truck is used for hauling sulphuric acid sludge

INCREASING BRINE OUTPUT FROM SALT BEDS

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BRINE used in alkali manufacture and for the production of table salt is frequently obtained by circulating water through wells drilled down to beds of salt. Such beds, formed by evaporation of sea water, are found in many parts of the United States, e.g., Central New York, Pennsylvania, Michigan, Ohio, Kansas, Oklahoma, Texas and Louisiana. The beds, with the exception of the so-called salt domes—great deposits of unknown thickness—usually consist of many layers, separated by intervening strata of shale formed by mud deposits.

As an example, a certain deposit in New York State is made up of four beds, 45, 25, 35, and 100 ft. respectively, in depth, with three intervening beds of shale totaling 95 ft. At Detroit, the bottom bed is 200 ft. thick with several thinner beds above, totaling 300 ft. in all.

The operating methods used in New York State, shown in Fig. 1, date back to 1888 when wells were put down through the 45-ft. bed. A 10-in. drive pipe was driven through the gravel into the rock, and a 6-in. casing was packed off in the rock below all water veins, inside which was suspended a 3-in. pipe, extending to the bottom of the bed.

The arrangement of the valves at the top makes it possible to force the water down through the 3-in. pipe, or inside the 6-in. casing, as may be desired. To dissolve out a cavity in a new well the water is forced down the center pipe, weak brine being driven out through the space between the pipe and the casing. After about six weeks the water is reversed and the brine forced out of the 3-in. pipe. As shown in the illustration, the fresh water attacks the salt just under the roof at a faster rate than the stronger solution and the shape of the cavity is an inverted cone which increases in size as indicated by the dotted lines. The impurities in the salt and in the water slide down the sides of the cone and are removed with the brine until the cone becomes so flat that it may settle and form a blanket on top of the salt which prevents further action by the water. The only surface then left is at the circumference, near the roof, the height of which remains sufficient to produce enough mud to form the blanket. With 15 per cent impurities in the salt a blanket of mud 1 ft. thick is formed, with a 5-ft. wall; with 10 per cent impurities the wall will be 10 ft. high.

In the Detroit plan, shown in Fig. 2, the water is forced down through the 3-in. pipe, making a pear-shaped cavity. Saturated brine cannot be obtained by this method, with less than 150 ft. of salt in the bed, because the water is 20 per cent lighter than the brine and rises through to the surface, thus diluting the brine as it passes through the annular space around the 3-in. pipe. With 200 ft. of salt as at Hutchinson, Kansas, the water mixes with the brine and becomes saturated. The cavity which first takes the shape of a pear later develops into a cone which finally develops a blanket of mud and assumes the same shape as in the New York plan.

When the cavity reaches 150 ft. diameter the shale roof is no longer able to support itself and caves in, adding to the blanket below, and cutting off or bending the 3-in. pipe, which must then be pulled out, whereupon the well is re-drilled through the loose debris, a difficult and expensive operation. As the cavity is enlarged, this caving repeats itself until the surrounding wall is finally blocked out and the well has to be abandoned. In a shallow bed caving occurs on an average of twice a year, in a deep bed about once a year, an expense of about $1,500 being incurred in each case.

If some salt is mixed with the shale of the roof, the fresh water may eat its way through and form a connection with the adjoining well, making it necessary to abandon the system of forcing the brine out of the well; pumping must then be done with an air lift or a deep-well pump.

Extended experience over a period of 40 years with over 100 wells led to a series of improvements in the system which resulted in a new patented method, the Trump plan, illustrated in Fig. 3. In this procedure, the water is held down to within 5 ft. from the bottom of the salt bed, and by allowing it to attack the salt only at the circumference of the cavity an under-cut is obtained, 4 ft. high and with a diameter as great as the salt bed is able to support. A diameter of 300 ft. has been obtained in one year, with 175 gal. of brine per min., and 500 ft. appears to be possible. Several methods have been devised to control the height of the water. A layer of air floating on the water prevents contact with the salt above a controlled height. This air is introduced into the water as it is forced down the pipe and is held in the water as bubbles and in dissolved state, the quantity dissolved depending upon the temperature of the water. At 15 deg. C. about 2 per cent, by volume, dissolves at atmospheric pressure; at 50 atmospheres the quantity is 100 per cent, or equal to the volume of the water. As salt dissolves, part of the air is driven out, until at the saturation point the water holds only a third

of the quantity dissolved in fresh water. A small surplus of air, above that remaining in the brine, is sufficient to control the level of the water by transferring that surplus to the upward current of brine at a desired level, or by reducing the pressure during transfer to represent a difference in water level.

With the arrangement shown in Figs. 1 and 2, an air supply connected to the water inlet, with several small holes in the 3-in. pipe, 5 ft. above the salt bed, will permit surplus air to enter the brine at the level of these holes, thus controlling the level of the water. A disadvantage of this method is the dilution of the brine with water introduced with the air; furthermore, the center pipe must be pulled out and the location of the holes changed when the level of the water is to be changed, such as when salt is to be attacked from below after completion of the undercutting when brine is to be produced. By placing a bell around the center brine tube, up through which small tubes are extending, the dilution may be stopped, but the pipe must be moved to change the level. It is important that the level be not raised more than 10 ft. at a time to prevent formation of cones.

An arrangement of casings and pipes which permits complete control at the top of the well and which will raise the level of attack by a simple manipulation of a small reducing valve in the ⅜-in. pipe is shown in Fig. 3. The well shown has a 3-in. central pipe, a 6-in. casing to below the top of the salt, and an 8-in. casing sealed into the rock below all water courses. An air connection to the 6-in. casing forces air into the water entering the well and an air outlet at the top of the 8-in. casing is connected to a ⅜-in. pipe, suspended in the 3-in. pipe with its bottom at the top of the salt bed. A valve capable of reducing the pressure at the bottom of the well to the pressure at the top of the salt bed is placed in the air pipe from the 8-in. casing to the 3-in. central pipe.

Air and water are forced into the well until the brine comes out of the 3-in. central pipe with the reducing valves wide open; the air will fill the space between the well and the 6-in. case and the annular space between the 6 and 8-in. casings, forcing the water down until the air begins to bubble out of the ⅜-in. pipe at the level of the top of the salt bed. By controlling the reducing valve the air will force the water down to the desired level, about 5 ft. above the bottom of the salt bed. The level will then be maintained until the desired undercut of up to 500 ft. in diameter is attained, whereupon the differential pressure caused by the reducing valve is reduced 5 lb., which will allow the water level to rise 10 ft., the water then will attack the salt over a wide area, producing a large quantity of saturated brine with a minimum removal of salt.

If an undercut of very large diameter is desired, by increasing the height in the center, the cavity may be made dome-shaped. This prevents caving of the salt.

The advantage of this arrangement is the control at the top of the well, without loss of air pressure. The same results maybe attained by beginning with the bottom of the central ⅜-in. pipe at the top of the undercut and raising it through a stuffing box, 10 ft. at the time, using valves to retain the pressure and re-connecting it to the 8-in. casing.

If a 100-ft. salt bed is assumed, with the sides having a slope of 2:1 as shown in Figs. 1 and 2, the diameter of the cone will be 400 ft. when a 10-ft. wall around the circumference is reached, making a volume equal to 279,000 net tons of salt. Using Fig. 3 with a 400-ft. undercut, the minimum cylindrical body taken out will be 837,600 net tons, and the area of contact to produce brine, when the water is raised, 125,663 sq.ft. The area of a 10-ft. wall around the circumference will only be 12,570 sq.ft., about one-tenth as much. At 800 sq.ft. per gallon of saturated brine per minute a well as shown in Figs. 1 and 2 will produce 15 gal. per minute, against 150 gal. per minute at start and 314 gal. per minute at the end for the one shown in Fig. 3. Caving of a well of the first type in a 50-ft. salt bed takes place twice a year, necessitating a repair cost of $3,000, in a bed of 100-200 ft. depth, $1,500 once a year only. A well as shown in Fig. 3 will only cave after all the salt is taken out, and will still have the surface in the

(*Please turn to page 368*)

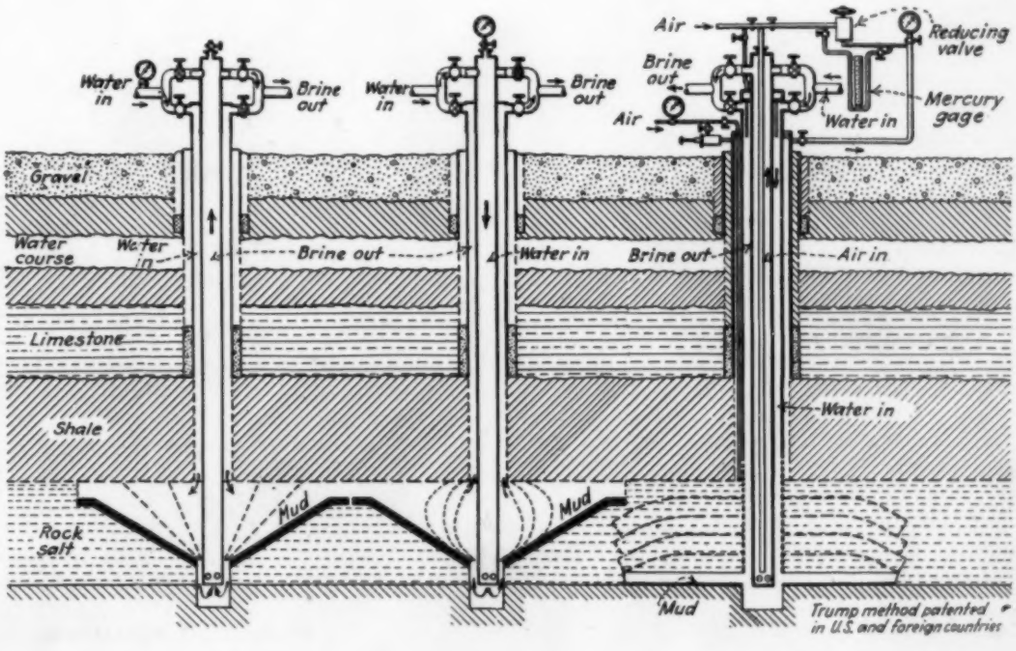

Fig. 1, Left—New York method, used for thin salt beds

Fig. 2, Center—Detroit system, applicable to beds over 150 ft. thick

Fig. 3, Right—Trump undercut method, used for improved yield in salt beds of any thickness

Handling and Shipping of Hydrofluoric Acid

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HYDROFLUORIC ACID is a corrosive agent which stands out in chemical industry as one demanding more than ordinary care in the adequate safeguarding of shipper, carrier and consumer. Bought for its ability to attack glass and metal, it becomes by this very characteristic one of the most difficult of chemicals to keep confined since shipping containers for liquid acids are usually of one or the other of these materials.

Changes, over a period of years, in the relative volumes of the 30, 48, 52 and 60 per cent strengths of hydrofluoric acid sold have had their effect, naturally, on the types of shipping containers most economically suited to the particular strength to be handled. When probably the largest part of the acid shipped was the comparatively weak 30 per cent strength which could be handled satisfactorily in wooden barrels, the container problem was of no such concern to the manufacturers, economically or practically, as it is today. But with increasing emphasis now being placed on the higher strengths, new container problems have been encountered. How they have been met is the subject of what follows.

Heretofore, the largest use for the 30 per cent strength was in pickling operations where sand was to be removed from castings prior to galvanizing. More recently, however, the cleaning of castings by sandblasting has been substituted in part, at least, for pickling, and electroplating has to some extent replaced galvanizing.

At the same time the sale of the 60 per cent acid has increased tremendously with the growth of the glass industry where it is used in the polishing and frosting operations. The inside frosting of electric light bulbs, for example, has developed extensively only within the last dozen years.

Limited to handling solutions of 30 per cent or less strength, the wooden barrel is still regarded as the most economical container in this restricted field. Non-returnable, it weighs 80 lb., holds 420 lb. of acid, and takes the third classification of freight rate, which is as low as any hydrofluoric acid container shipped in less than carload lots. However, its use presents several problems, not all of which have been satisfactorily solved.

Before wooden barrels can be used for hydrofluoric acid they must receive an inside coating of pitch. This is an operation which has to be carried out after the barrel heads have been put in. With access to the interior of the container limited to the bung hole, the hot pitch must be applied by pouring through this opening and spreading evenly throughout the interior by rotation of the unit. Inspection of the completeness of the coating job must be left largely to the test for leaks which is made during an 8-hour storage period after the container has been filled with the acid to be shipped.

Pitch is used as the coating because of its property of remaining fairly pliable under ordinary conditions of shipping and temperature. If, through extraordinarily rough handling, this lining is cracked the seepage of acid through it and the wood staves of the barrels will create much or little damage depending on the extent to which one or more of the four or five metal hoops of the container lie in the path of the leaking liquid. Once started, corrosion of the metal hoops is rapid and the barrel must be emptied as much in the interest of safety as to conserve the contents. At the best, from the consumer's point of view, a wooden barrel is not a satisfactory storage receptacle for hydrofluoric for more than 30 to 60 days at the most. For safety, therefore, it is generally recommended that shipments of the acid be made to coincide as nearly as possible, within these limits, with actual use requirements.

Lead Carboys for Stronger Acid

But the wooden barrel is not the only container for the acid to present handling and shipping difficulties. Boxed lead carboys, until recently the mainstay for handling commercial strengths higher than 30 per cent, weigh 108 lb. and hold only 100 lb. of acid. The biggest problems—and hazards—in connection with their use are caused by this weight factor and the inability to roll a square boxed receptacle. The weight of the full carboy, 208 lb., precludes its lifting or sliding more than a short distance by one man. A hand truck or other piece of mechanical conveying equipment is required, not only in the acid manufacturer's plant but in the customer's plant as well.

In less than carload shipments, lead carboys take the first class (highest) freight rate going to the customer and a third class (or Rule 25) in being returned empty. Moreover, at least in the experience of The Harshaw Chemical Co., of Cleveland, maintenance has always been quite a factor with these lead containers. Not only have they been subject to injury from rough handling—particularly when being returned empty—but structurally they have required painstaking inspection after every

trip, and all too frequent attention from the lead burner to seams and vent and discharge nipples, in compliance with ICC regulations. The very minimum of maintenance, in fact, has included the removal of the container from its wooden jacket, the latter itself subject to frequent repair, and the air testing for leaks, accomplished by submerging the carboy in water. Generally some reinforcement of the outside seams of the 0.13 in. thick lead wall or 0.165 in. top or bottom sections has been needed as a safety measure. The usefulness of the carboy, then, has at the most been limited to a dozen trips, with an average of considerably less.

Offsetting these difficulties to some extent, however, is the fact that with the lead carboy there is less splattering because it is equipped with an air vent as well as a pouring spout. All the other types of container, wood, steel, and rubber, are limited to the single opening because of structural weaknesses which would be introduced if an additional opening were provided.

Hydrofluoric acid in the 60 per cent strength can be shipped in lead, steel or rubber containers. The steel unit has been found to be quite a practical package from the standpoint of both storage and handling. The 20-gal. container is a compact unit which, being equipped with rolling hoops, is fairly easy to handle, even though its weight when full is 245 lb. Empty, it weighs 70 lb. It holds 175 lb. of 60 per cent acid and takes the third class freight rate *both* going to and coming back from the customer.

110-Gal. Drums for Large Shipments

A larger 110-gal. steel drum, also confined to the 60 per cent acid, weighs 225 lb. empty and holds 1,000 lb. of acid. These larger containers are carried one or more at a time on trucks, or are shipped in carload lots of 27 to 28 drums. Both the small and the large steel container, having steel heads and sides, have the advantage of nominal maintenance as well as low first cost. The 20-gal. size requires a $7 deposit and averages probably not more than seven trips with complete safety. The 110 gal. size requires a $20 deposit, averaging about the same number of trips as the smaller unit. The only disadvantage of the larger size is its weight of 1,225 lb. when full. In spite of being cylindrical in shape and equipped with rolling hoops, it is pretty cumbersome to move about.

The biggest cause for concern in the use of the steel container, large or small, is the possible damage to, or destruction of, the iron fluoride coating of its interior. Each drum, before being put into service, must be passified (in effect, a formation on the interior surface of a coating of iron fluoride) by being filled to 90 per cent of capacity with hydrofluoric acid of 58 per cent strength and allowed to stand 48 hours at a temperature of 80 deg. F.; then in an oven for seven hours at 140 deg. F.

Rough handling may dislodge some of this protective lining and expose the surface to further attack of the acid which, because it is then not under the controlled conditions observed in the original passification process, will not necessarily stop at stabilization, but may continue to eat completely through the 14 gage (small) or 12 gage (large) steel wall of the container. This coating can also be destroyed by washing or rinsing out an emptied drum, since iron fluoride is readily soluble in water. Despite instructions to the contrary, lettered conspicuously on every steel unit, this rinsing out of the drums has continued to occur frequently enough to be a problem which militates against the otherwise satisfactory performance of the container.

Wooden barrels, lead carboys, steel and rubber drums are all used in shipping hydrofluoric acid

A final difficulty with steel drums, both small and large, is that they must be shipped and stored on their sides to keep the acid away from the bungs which are situated in the sidewalls. This presents something of a problem to the transportation agency as well, since the drums cannot be stacked in loading but must be strapped securely in place.

To minimize the corrosive action of the hydrofluoric acid on the threaded sections of bung and plug, the Harshaw company has developed a special closure of its own which is designed to prevent the acid coming in contact with the threads. Putting the threads on the outside of the bung projection and substituting a threaded cap for the plug, a form of construction has been evolved that not only prolongs the life of the container but also eliminates many of the difficulties in opening which might otherwise develop from the action of the acid in "freezing" internal threads with which it had come in contact.

Within the past few months there has become available a rubber drum which weighs 35 lb., holds 100 lb. of acid (rated capacity 13 gal.) and takes the lowest freight rate for this type of acid both going to the customer and returning. With no steel hoops to be attacked by leaking acid, no lining of iron fluoride to keep unbroken, and no box to prevent its being rolled about a plant by hand, it possesses the further advantage of being practically indestructible. It is not subject to leaks which would constitute shipping and storage hazards, and can be handled in its upright position because the bung is in the end.

Most important of all, because it is constructed throughout from vulcanized, laminated rubber of about $\frac{1}{2}$ in. thickness, with a special inner lining of paraffin-impregnated pure gum rubber, there is no limitation on the hydrofluoric acid strengths which can be satisfactorily handled, up to and including 60 per cent. Although it is desirable to use a special device for emptying the container, either a short hose length with pinch control or a more complicated syphon and pressure arrangement, the only serious deterrent, apparently, to the widespread adoption of the rubber drum is an economic one—its high deposit of $15 per unit which, by comparison with the deposits on the wood, lead, or steel units, remains somewhat out of line.

Rubber Drums Gaining Acceptance

Before the introduction of the rubber drum, about 20 per cent of the hydrofluoric acid produced, taking the Harshaw company as typical, was shipped in wooden barrels. The rest, the higher strengths, was divided about equally between steel drums and lead carboys. With the introduction of the rubber container, however, these proportions have changed so that at the present time less than 10 per cent of the shipments is handled in lead carboys, some 20 per cent in wooden barrels, and the balance in steel or rubber drums. Eventually, especially if the first cost of the rubber container can be reduced—possibly through its application broadly for the shipment of a number of other chemicals whose volume sales are many times larger than that of hydrofluoric acid—rubber may replace all but the wooden barrel in the handling of hydrofluoric.

To simplify the selection of the most economic container for a particular shipment of hydrofluoric acid, the Harshaw company has reduced to formula the economic factors involved in the choice of container, taking into consideration the weight of the loaded drum, and its weight empty (for return). If, on a given freight rate the factor for the wooden barrel is taken as 1, that for the rubber will be 1.41; for the 20-gal. steel container 1.5; and for the lead carboy 2.4.

Larger Rubber Drum Now Needed

There exists a real need, so The Harshaw Chemical Co. feels, for a larger rubber container of 30 or perhaps even 50 gal. capacity. Attempts have been made to develop these; but so far only the 13-gal. size has been approved by the Interstate Commerce Commission. The advantage of a larger size to the chemical manufacturer would be the reduction in the number of sizes and types of container which would have to be carried in stock adequately to serve his customers. On the part of the consumer the advantage would lie in the reduction possible in the amount of cash kept tied up in deposits on the greater number of small containers required under present circumstances to handle the equivalent quantity of hydrofluoric acid.

(*Continued from page 365*)

surrounding wall to produce 150 gal. of brine per minute, instead of 15 gal.

A complete well costs about $10 per foot or $25,000 for a well 2,500 ft. deep. The new type of well has been tested thoroughly in several instances and the undercutting proved by developing wells 150 ft. apart until they connect with each other. From the volume and the analysis of the brine the height of the undercut was proven. The time required to undercut a well 5 ft. high and 400 ft. in diameter is about 500 days. Using 175 gal. of water per min. the salt taken out will be 39,270 tons. To obtain the same surface in a sphere as shown in Fig. 2, before starting to saturate the brine, the diameter would have to be 200 ft. and the volume equal to 523,513 tons of salt, over thirteen times as much salt wasted. With sufficient time to develop, brine may be produced while undercutting. If saturation is started at 200 ft. diameter, 10 gal. per min. is obtained.

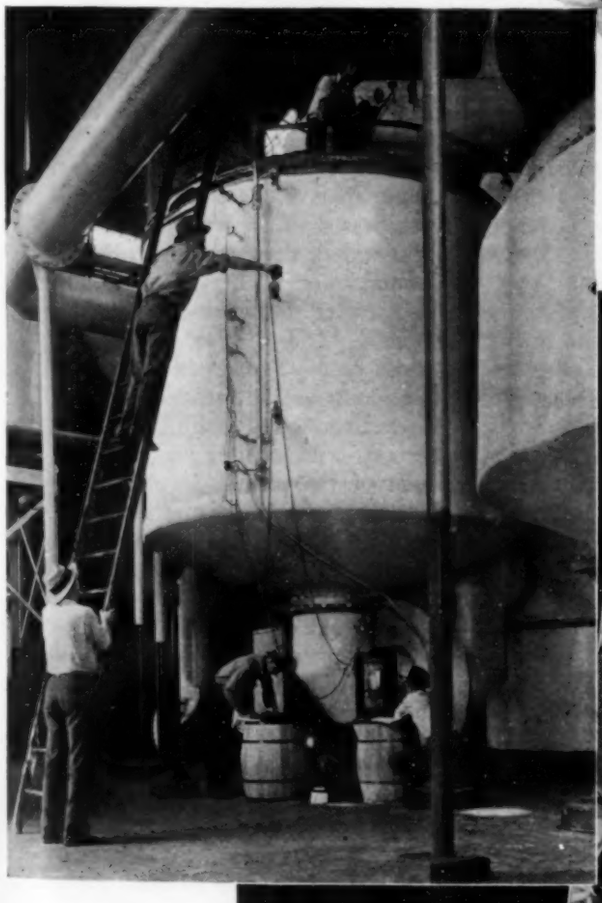
The shape of the cavity shown in Figs. 1 and 2 is based upon actual observations in two abandoned German wells, in which the production of brine had almost completely stopped. A shaft had been sunk and a tunnel driven into the cavity. The two wells, about 125 ft. apart, had perfectly circular cones, connected so both cavities could be seen at the same time by the aid of magnesium flares. Although the bed was 300 ft. thick, the cones were only 30 ft. high.

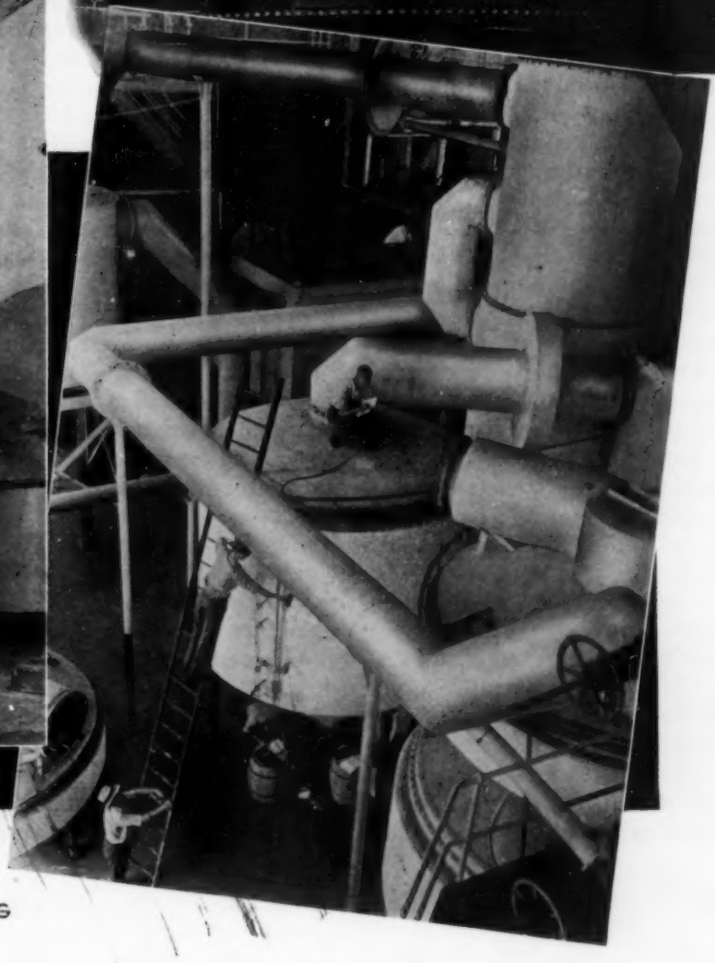
The sides of the inverted cone were covered by a 6-in. layer of soft anhydrite, the salt bed had paper thin layers of anhydrite about $\frac{1}{4}$ inch apart which blanketted the salt as it fell on the sides of the cone.

Salt beds are so different that every well presents its own problem. Impurities may vary from 3 to 15 per cent and the layers of salt are not always horizontal. To arrive at the best solution a study of the field must be made and operation of the well modified accordingly.

PRACTICE MAKES PERFECT

The School of Chemical Engineering Practice is maintained by the Massachusetts Institute of Technology to enable graduate students in chemical engineering to apply the fundamentals of science and engineering which they have been learning to the solution of industrial problems. Field stations at the Everett, Mass., works of Merrimac Chemical Division of Monsanto Chemical Co., at a pulp and paper mill in Bangor, Maine, and a steel mill in Buffalo, N. Y., provide a breadth of background for the study of chemical engineering operations. Groups of about eight to twelve students spend eight weeks at each station in the course of their training and then return to Technology for further graduate studies toward the degree of Master of Science. Prof. R. C. Gunness of M.I.T. is in charge of the students at the Everett plant shown in the illustrations.





New Data on Design of Simple Paddle Agitators

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ALTHOUGH the flat-blade paddle agitator is losing its former importance as a stirring device, its ruggedness, simplicity and ease of construction in the company shop, together with its undoubted ability to do good mixing, have kept this device in operation despite the inroads of more modern high-speed mixers. It has seemed worth while therefore to investigate some of the characteristics of this machine, in the hope of eliminating part of the guess-work in its proper selection.

Apparently, the average tank is fitted with a flat-blade agitator more or less on the hit-or-miss plan. Often the largest paddle possible is inserted into the tank and made to rotate at any speed which an available gear train and motor happen to give. The motor size and corresponding power demand are estimated, if calculated at all, by some rule-of-thumb method based on the rated capacity found on the name-plate of a motor that someone else guessed at for a similar job. With a view toward supplying some of the missing links in the chain of agitator design, some years ago a study of paddle agitators was undertaken in the chemical engineering laboratory of the University of North Carolina. The present paper attempts to summarize in a form useful to the designer the conclusions which the authors have reached to date. Many questions are still debatable and the subject of agitation as a scientifically treated unit operation has barely been cracked. It is felt, however, that some progress has been made, and that though the results are relatively crude and inaccurate in spots, they may serve to simplify mixing operations.

In selecting the proper paddle agitator for a given tank several questions naturally arise. What is the optimum paddle size? How much power will it consume? How fast should it revolve? How long will it take to reach a steady state? Will the resultant mixture be uniform? Some of these questions can be answered completely only by experiment, but satisfactory approximations can be made for several of the others.

One of the more difficult mixing problems, and that on which the large part of the present experimental work has been done, is the suspending of a dense solid in a liquid. The experimental procedure has been previously described (White *et al., Ind. Eng. Chem.*, **24**, 1932, p. 1160; **25**, 1933, p. 1025; **26**, 1934, p. 82) but a brief summary may not be out of place. A weighed quantity of sand of known screen analysis (preferably screened to a definite size) is added to a known quantity of water and stirred with a simple symmetrical paddle in a cylindrical, unbaffled tank. The resultant suspension of sand in water is sampled by means of tubes passing through stuffing boxes in the wall of the tank, drawing off samples at various points, which are subsequently analyzed by filtration and weighing. A variety of paddles can be used as well as a wide range of agitator speeds.

Optimum Paddle Size

The series of paddles tested ranged in length from one almost equal to the tank diameter to one so short that it failed to pick up a measurable quantity of sand. For the 51-in. tank used in the majority of these runs the paddles varied in length from 12 to 47 in., and in width from 2 to 8 in. The rotational speed was varied between limits of approximately 20 to 80 r.p.m. Nine different sampling points were used, the results being similar for each point.

In Fig. 1 are plotted curves of sand concentration versus paddle length for speeds of 37 and 55 r.p.m. respectively, other variables being held constant. These results are typical of those found in all runs. In every case there is a hump-shaped curve with a peak at a paddle length slightly less than the tank radius. For the 51-in. tank, here illustrated, the optimum paddle is one 24 in. long. This maximum concentration is observed at the same length-diameter ratio independent of paddle width, quantity of sand, sand size, or rotational speed. In other words there seems to be special virtue in a paddle about half as long as the tank diameter. This effect appears to be connected with some sort of resonance phenomenon, with reinforcing of a periodic flow by the rotation of the paddle in phase with the circulating motion. Study of this point is under way at the present time. With paddles larger or smaller than the optimum size, sand concentration drops very rapidly to low values for extremely short or very long paddles. That paddle about equal in length to the tank radius is therefore recommended as most effective.

The effect of paddle width on sand concentration is much less marked. However, there seems to be a slight advantage in designing the paddle so that the width is about one-fourth of the length.

As has been previously shown, uniformity in concentration is never attained in suspending sand in water by means of a simple paddle agitator (White, *loc. cit.*). At each sampling point, however, the effective concentration is highest for the paddle about equal in length to the tank radius. In general the maximum quantity of sand is suspended with the paddle near the bottom of the

tank (as a rough approximation let the distance between paddle and tank bottom equal the width of the blade). With the paddle near the surface of the liquid a much smaller quantity of material is suspended but the resultant distribution is more uniform.

There exists for each particular case a speed higher than which it does not pay to operate. This limiting agitator speed, called the saturation point, is one at which further increase in speed produces little or no increase in concentration. At speeds below this critical value sand concentration is markedly affected by rotational speed. The saturation point will depend in part on the size and quantity of solid to be suspended, hence is best determined experimentally for each case. As the power consumed by an agitator rises very rapidly with speed it is obviously wise to use as low a speed as will give the desired concentration. It is suggested that paddle agitators be operated at or slightly below the saturation speed, because a greater speed uses increased power without accomplishing additional suspending of solids, while at lower speeds the quantity of material suspended falls off rapidly.

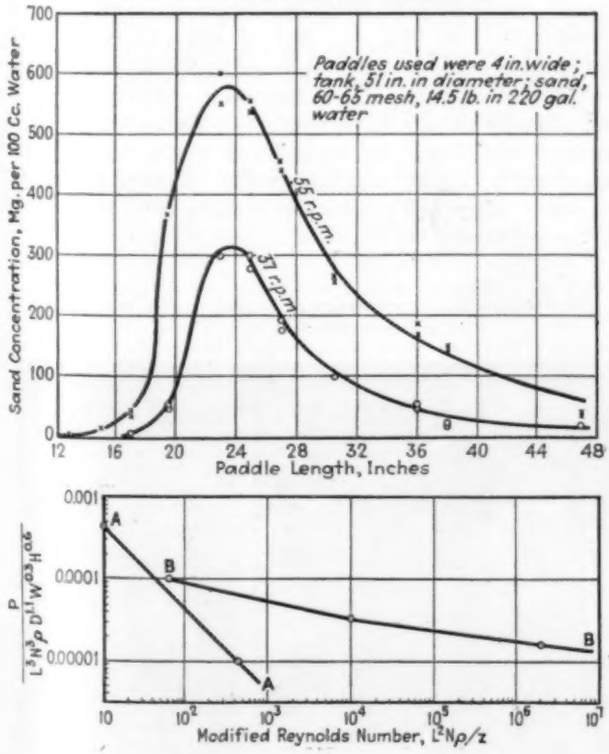
Power consumed by an agitator has been measured by means of dynamometers as described by White *et al* (Trans. A.I.Ch.E., **30**, 1934, pp. 570, 596). An approximate correlation of the resultant data is given by the curves of Fig. 2, in which the group

$$\frac{P}{L^5\ N^3\ \rho\ D^{1.1}\ W^{0.3}\ H^{0.6}}$$

is plotted against a modified Reynolds number, $L^2N\rho/z$. In this figure the symbols have the following significance: P=horsepower; L=paddle length (ft.); W=paddle width (ft.); N=agitator speed (r.p.s.); z=liquid viscosity (lb./sec. ft.); D=tank diameter (ft.); H=liquid depth (ft.); and ρ=liquid density (lb./cu. ft.). In this form the curve is very similar to the usual friction plot, with turbulent flow (curve $B-B$) at the right and viscous flow (curve $A-A$) at the extreme left. The exact location of the transition from turbulent to viscous flow, here shown at a Reynolds number of something under 100, is in need of further investigation, as is the entire viscous range. Of the exponents included in the plot of Fig. 2, that of tank diameter is the least certain. While a great deal more work is needed on this subject, it is felt that this curve may be used in the estimation of the power consumption of paddle agitators within limits of error of perhaps plus or minus 40 per cent. This correlation represents a slight modification of that given in the A.I.Ch.E. paper cited above.

Fig. 1—Effect of paddle length on sand concentration

Fig. 2—Power consumed by paddle agitators


Paddles used were 4 in. wide; tank, 51 in. in diameter; sand, 60-65 mesh, 14.5 lb. in 220 gal. water
55 r.p.m.
37 r.p.m.
Sand Concentration, Mg. per 100 Cc. Water
Paddle Length, Inches
A
B
Modified Reynolds Number, L²Nρ/z

Rate of Mixing

The simple paddle agitator, operating without baffles, does a surprisingly good job of mixing, a fact which has long been known (Wood, Whittemore and Badger, *Chem. & Met.*, **27**, 1922, p. 1176). In the matter of a minute or so after the start of mixing a steady state is attained. However, as previously remarked, uniformity in distribution of suspended solids is not attained. With miscible liquids a uniform solution is obtained very rapidly, so rapidly that it is impossible to differentiate between machines on this score alone. Much early work on agitation was done in the hope of evaluating mixing machinery by means of mixing rates. The speed of mixing of miscible liquids in properly proportioned agitators, or of suspending solids in liquids, is in most cases sufficiently great that nothing is accomplished by a further reduction in mixing time. It should be pointed out that the above statements apply only when no chemical reaction or other time-consuming process is superimposed on the simple mixing problem. In general, time must be allowed for a reaction to take place in addition to a uniform distribution of material. The suspended solids of the usual heterogeneous reaction mixture are best kept afloat when stirred by paddles of dimensions previously given, the propeller agitator being excluded from this discussion.

Fluffy powders are difficult to incorporate by means of a paddle agitator and are best distributed into a liquid by a high-speed propeller mixer.

With an ordinary paddle agitator there is a certain amount of hydraulic classification of the solid suspended in various parts of the tank, a corollary of the nonuniformity of distribution of solid in liquid. The largest particles, and the densest, tend to remain under the paddle while the finer and lighter ones rise.

In summary, assuming that the flat-blade type of agitator has been selected for a giving mixing operation, it is felt that the best paddle design is one with a length slightly less than the tank radius, a width equal to one-fourth the paddle length, and placed about one paddle width from the bottom of the tank. It should be rotated at an experimentally determined speed such that further increase fails to accomplish additional suspension.

Designing a Condenser for Steam Distillation

By CHESMAN A. LEE
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IN DESIGNING a condenser for a certain material distilled with the aid of steam, several interesting problems arose, and with them the realization that they were not covered in any of the available texts. The case is one which might be met in the steam distillation of any organic liquid of high boiling point and hence should be of general interest. The basic principles, naturally enough, are merely those of ordinary physical chemistry. However, the writer has observed a number of instances in which their neglect on the part of reputable equipment builders has resulted in unsuccessful designs.

The problem involved, in effect, is to condense a vaporized product from an atmosphere consisting of an excess of "non-condensible" vapor, quite a different problem than that encountered in the distillation of ordinary homogeneous mixtures. The "non-condensible" vapor is steam and our discussion here will be confined to the case of organic liquids which are practically insoluble in water and hence not affected by the steam used in their distillation. Equilibrium in steam distillation exists when the vapor pressure of the liquid, plus the partial pressure of the steam, is equal to the total (absolute) pressure above the liquid. Vaporization occurs with the addition of heat and condensation upon its removal. When steam is used for its partial pressure effect, it is called "open" steam. It is superheated at the temperature of operation and is condensed separately from the material being distilled by means of a second condenser following the product condenser.

In steam distillation the vapors are continuously removed and a certain condition of absolute pressure, usually a vacuum, is maintained. The temperature is held constant by the addition of heat and steam is bubbled up through the liquid to emerge more or less saturated with vapors from the liquid. The degree of saturation attained depends upon the size of the bubbles, their dispersion, and other factors making for completeness of contact. At the theoretical saturation point there is a definite ratio between weight of material in the vapors and weight of steam, as given by the well-known expression:

$$\frac{W_m}{W_s} = \frac{P_m M_m}{18 P_s} \qquad (1)$$

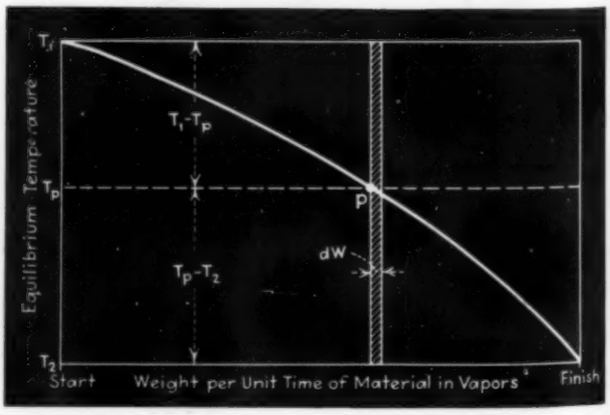
where W_m = weight of material; W_s = weight of steam; P_m = vapor pressure of the material (a function of the temperature); P_s = partial pressure of the steam; M_m = molecular weight of the material; 18 = molecular weight of the steam; and $P_m + P_s$ = absolute pressure in the still.

It is evident that if we add open steam at a uniform rate, we may expect to distill in a certain ratio provided that we add heat at such a rate as to maintain a constant temperature. It might be concluded from this that the same temperature will be found in the condensing equipment, but such a conclusion would not even be approximately true.

To begin with, the vapor mixture, as noted above, contains somewhat less than the equilibrium quantity of material and must be desuperheated by the removal of sensible heat before condensation can occur. A superheated vapor is similar to a hot gas and the rate of heat transfer from it to the condensing surfaces is extremely low. Then, as condensation of the material commences, the ratio of material in the vapors to the steam begins to change (for the steam is not condensed until a later stage) so that each increment of condensation superheats the remaining vapors. Hence a constantly recurring cycle of desuperheating, condensation and superheating takes place in the condenser and no definite temperature of condensation can be stated to hold for the entire condenser.

The effect is easier to visualize if we consider the material as condensing inside a single long tube. Vapors enter at one end and are cooled in passing through a certain distance until some condensation occurs as the saturation, or equilibrium, temperature is reached. Now, however, the partial pressure of the material is decreased and the remaining vapors must be still further desuperheated to a new equilibrium temperature before additional condensation can occur. This process continues by infinitesimal stages and the temperature varies along a smooth curve with progressive condensation to the end of the tube. At the exit end of the condenser there will still be some material left in the vapors at equilibrium with the steam and at a temperature appreciably less than that for the initial equilibrium. The actual condensation coasts down the equilibrium curve and the desuperheating of the remaining vapors follows after. At the same time condensate travels along with the vapors and is sub-cooled on the way.

Chart illustrating condensation of organic vapors in presence of uncondensed distillation steam



The important point to be grasped from this analysis is that the heat removed during condensation is divided into three parts: (1) Sensible heat released in cooling the vapors to the particular condensing temperature involved; (2) latent heat of condensation at that temperature; and (3) sensible heat released in cooling the condensate to some final temperature. Furthermore, as a result of the peculiarities noted, the mean temperature difference is considerably less than would be imagined, with the result that a good deal of extra condenser surface is required.

Three Heat Transfer Coefficients

At any one point along the condenser material exists in three states: (1) Vapors being desuperheated, to be condensed at some later point; (2) material condensed at the point in question; and (3) material already condensed and being sub-cooled towards the final temperature. These three separate steps require widely different coefficients of heat transfer and it does not seem logical to use an overall value for K. Except in cases where everything is strictly parallel to past experience, it would seem greatly desirable to figure total surface as if made up of three different parts separately required, and each with its own coefficient. Even so, it will be shown that the solution is simple.

It is desirable to know the total quantities of the heat to be transferred in the three steps and also the terminal temperatures. For illustration we considered a single tube with vapors inside. In a practical exchanger many tubes are used and these are ordinarily arranged in multipass with vapors outside. However, the principles are the same and the practical design can equally well be calculated from a chart based on similar reasoning.

Before figuring the required curve, it will be convenient to note that the weight of steam in the vapors does not change, and hence to rearrange equation (1) as follows:

$$P_m = \frac{W_m k p}{1 + W_m k} \qquad (2)$$

where k is the constant factor, $18/W_s M_m$, and p is the absolute pressure in the condenser, or $P_m + P_s$. Often vapor pressure data will be available covering the entire range. If detailed data are not available, two known points may be used to plot a straight line with log P_m vs. the reciprocal of the absolute temperature or a Dühring chart may be constructed.

It is now a simple job to plot the weight of material remaining in the vapors passing through the condenser per unit of time, against the corresponding equilibrium temperatures, as shown in the accompanying graph. As condensation is progressive along the path through the condenser, the abscissas of the diagram are functions of the distance along that path. Every point on the curve represents some position in the condenser. Furthermore, a vertical line through any point on the curve gives the history of material condensed at that point. Consider the infinitesimal weight of material, dW. As shown on the diagram, this quantity is cooled in the vapor state through the range $(T_1 - T_p)$, condensed at some point P and cooled as liquid through the range $(T_p - T_2)$. Heat, then, must be absorbed from this material in three installments, namely: (1) Sensible heat in the vapor $= (T_1 - T_p)\ C_{vap.}\ dW$; (2) latent heat of condensation $= L\ dW$; and (3) sensible heat in the liquid $= (T_p - T_2)\ C_{liq.}\ dW$. Here C is the specific heat and L is latent heat, assumed constant between T_1 and T_2. It follows that the total heat of the three steps equals the sum of the integrals of these three expressions, or (area above curve) $C_{vap.}$ + (total weight of material per unit time) L + (area below curve) $C_{liq.}$. These areas are easy to determine and give very simply the total quantity of heat to be transferred.

We now have sufficient data to permit figuring the total surface required. It is, of course, to be expected that extra surface will be added to provide a working margin. This extra surface, besides allowing for approximations in selecting the coefficients, also provides for the fact that there is a temperature gradient in passing from the wall of the tube through the film of condensate to the vapor interface. (For, at any one point in the condenser, liquid film is being sub-cooled by tube surface at one temperature, while vapor is being condensed outside the liquid film at a higher temperature.)

Values for K must be selected from experience with the type of equipment under consideration (i.e., whether the tubes are horizontal or vertical, the vapors inside or outside the tubes, and baffled or not, etc.). For one job coefficients of 1.5 for desuperheating, 20 for condensing and 7 for cooling seemed indicated and gave a good design. Whatever coefficients may be chosen, however, one should never forget that these three steps in question are actual divisions in heat transfer and must be treated accordingly.

Metal Lining Improves Concrete Tanks

By HUGH E. WEIGHTMAN
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CONCRETE makes an ideal material from a construction viewpoint for fabricating storage and processing tanks. Its most serious fault is that the concrete itself is more or less disintegrated by the action of chemical solutions generally. By lining the working surfaces with metals and the use of some special features in design of such tanks it is possible to produce tanks of large size at much less cost than with all-metal construction. Properly constructed concrete tanks have a longer life and are safer than wood tanks. While wood and metal tanks have their proper place in the industry there are many places where the proposed concrete construction is superior. Most if not all of the failures

of concrete construction in the industry are due to a lack of proper design. The literature is strangely bare on the subject of concrete construction in the chemical plant. The protective treatments suggested by various agencies are generally in the nature of coatings which are subject to all the ills of porosity and local breakdown.

When tanks are lined with metals, support should be given at as many points as possible to prevent buckling and creepage. This is particularly true with lead linings. For that reason the tank should be divided into panels by bars attached firmly to the tank surfaces, to which the metal lining may be welded.

The lining is then laid in convenient sized sheets with the edges welded or burned to the bars. Additional protective strips are welded over the bars, thus connecting the lining into one complete sheet. In long tanks where expansion must be taken up, a V-shaped strip may be welded to the sheet over the bars. The details for this purpose will be evident to the designer when laying out the construction. The panel bars are best held to the tank by studs through the tank body. To make replacement possible these studs should be free of the tank body. Pipes run through the concrete flush with the tank can be used and set when the forms are placed. If the pipes are painted with pitch before setting they may be slightly heated and pushed out of the concrete after the forms are removed and thus leave no iron in the holes. This is desirable since if corrosion sets in, the increased bulk of the corroded pipe may crack the concrete locally.

Reinforcing steel in the concrete should be well distributed. Smaller bars on smaller centers are preferable to larger bars at greater centers, the net steel area per unit surface being the same in each case. Adequate steel should be placed in the concrete so as to confine the shrinkage cracks to mere hairlines. For the same reason, more longitudinal steel is required than is usual in building construction.

It is unnecessary to imbed the steel a greater depth than an inch to an inch and a half in the concrete nor is a slush or mortar coat desirable on either inside or outside surface of the tank.

Corners should be given a large radius and the reinforcing steel placed so as to avoid cracks at these points. The design methods in this respect are well known to competent designers but are often neglected in building tanks. Radii of 8 in. to 15 in. are satisfactory. In no case should the radius be less than 6 in.

Though not required by the load, added reinforcing should be used along the top of open tanks to prevent open cracks and damage by working over the tank. Linings should be carried over the top of open tanks.

Long tanks should be built in sections not to exceed 15 ft. longitudinally and these sections joined by the sleeve and bar construction so common in highway construction. Sections should be separated by expansion joints of treated asbestos.

On large tanks it is preferable to use an arch type floor and transmit the load to the longitudinal edges of the tank and then to use a sand cushion between the tank footing and the base to allow movement to take place.

A good bulk concrete base, reinforced if need be, and of reasonable levelness should be constructed where the tank is to be installed. After this footing is thoroughly dried out the top should then be given a brush treatment with hot asphalt and while wet a dried sand should be sprinkled over the surface. The sand should then be rolled and leveled until a half-inch coating has been built up. If the tank sections have been precast they may then be set in place. If the tank is to be cast in place a layer of roofing paper should be placed at the bottom of the forms to prevent the concrete from flowing into the sand cushion and thus destroying its effect. As an alternate type of construction the sand cushion may consist of thoroughly dried sand impregnated with light oil.

The mixture for the tank is best made 1:1½:3, using clean sharp sand and a stone consisting of half limestone and granite rock. The size of the rock will be governed by the section of the concrete as in the usual concrete design. The mix should be wet enough to make the concrete follow the forms and leave no voids but no more than this. No attempt should be made to render the concrete impervious to fluid since the concrete in this case is a mechanical structure.

After the concrete has been thoroughly dried out the surfaces should be given a coat of hot asphalt. After this the lining support bars may be put in place and construction of the lining begun. The lining can best be welded electrically. When welding with a gas flame a phenol resin coating should be used in lieu of the asphalt coat to prevent burning and the possibility of the coating oozing through the weld during construction of the lining.

In arranging for lead linings the support bars should be placed so that no panel is wider than 2 ft. on walls and 4 ft. on tank floors. The support bars should be at least as thick as the lead to be placed and in no case less than ¼ in. thick. The usual width of bar suitable for this purpose is ½ in. wide. Bars ¾ x ⅜ or ¼ in. make suitable supports for lead linings, using half ovals. Bevel edge flats are the easiest to handle when installing thin sheet linings such as stainless steel or nickel. Such sections give ample thickness for stud attachment with a thin edge for ease in welding the sheet.

There is not much to be gained by applying a lining to the tank exterior except at the corners for protection against mechanical damage. With the construction outlined above any leakage in the tank will be discovered as it seeps through the stud holes. Should an exterior lining be used it may cover up the location of such leaks and thus result in damage to the concrete tank.

Earlier in the paper a 1:1½:3 mix was recommended. This is much richer than the 1:2:4 mixture commonly used for this purpose. It is recommended for the reason that it costs but 15 per cent more per cubic foot of concrete but being stronger by some 30 per cent permits the use of thinner sections. When used with the granite mixture the structure withstands temperature stresses better and is not so easily damaged by leakage. A concrete of this type is well suited for handling organic materials without lining where such materials slowly attack the usual concrete.

Energy Recovered by Pressure Exchanger

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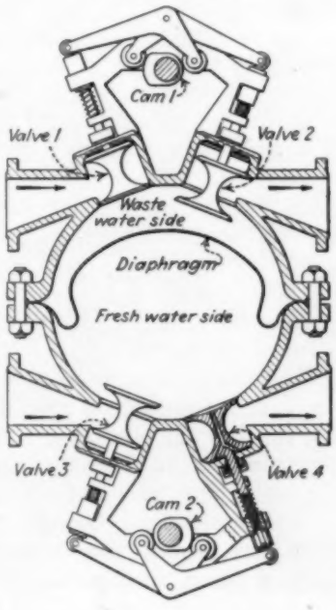
IN GAS PURIFICATION at high pressure, large volumes of scrubbing water are wasted under relatively high heads, and substantial savings can be realized by recovery of a portion of the potential energy. A simple device for exchanging pressure between contaminated waste water and inflowing fresh water has been developed which, briefly, consists of a pressure vessel, a diaphragm which prevents diffusion but freely transmits pressure from the waste to the fresh water, and a system of valves for controlling the cycle of operation.

The construction of the exchanger is indicated in the accompanying drawing. The spherical steel shell is designed to withstand the full pressure of the waste scrubbing water and is constructed in halves. A light rubber diaphragm, molded to fit the inside contour of the shell, is secured by the flanged joint in the ordinary gasket position. The valves are designed so that when closed they preserve the uniform inside contour of the shell. The objects of this construction are two-fold: (1) To form an unbroken surface against which the diaphragm may be thrust without rupturing in case one side is accidently subjected to full pressure when all of the water has been expelled from the other side; and (2) to eliminate all pockets wherein gas evolved from the waste water might become entrapped. Trapping of gas within the exchanger would result in poor efficiency. The valves are a modification of the balanced poppet type. Two cams driven in synchronism by a motor actuate the valves. The actuating mechanism includes a spring relief on each valve to prevent damage to the diaphragm. This mechanism is shown in the sectional view of valve 4. The rocker arm actuates a thrust sleeve which compresses the main valve spring and transmits the actuating force to the valve stem through a secondary spring. Should the diaphragm bear against the valve head, the secondary spring will be compressed sufficiently to prevent rupture, but a stop on the thrust sleeve will prevent the valve from closing absolutely tight.

Pressure exchanger shown in cross section



The cycle of operation of the exchanger is as follows: While the valve settings are as shown, fresh water enters through valve 3 under sufficient pressure to flex the diaphragm and expel the waste water through valve 2. When the diaphragm approaches the upper limit of its travel, cams 1 and 2, which are timed to change the valves just before the diaphragm reaches the end of its stroke, actuate all the valves so that 2 and 3 close and 1 and 4 open. Waste water under scrubber pressure then enters through valve 1 and the fresh water is forced out through valve 4. As the diaphragm approaches the end of the downward stroke the valves are returned to their initial position and the cycle starts over again.

The design for each unit includes three exchangers operating in parallel with the valves timed to give a steady flow of water. A unit designed for a flow of 5,500 gal. per minute has spheres 4 ft. 3 in. in diameter with twin valves (eight per sphere) each 1 ft. in diameter. The diaphragm is ordinary vulcanized rubber with a fabric insert to increase its strength. This design is based on experience gained from actual operation of a semi-works scale pressure exchanger during February, 1933.

Three auxiliary centrifugal pumps are required in conjunction with the pressure exchanger. One single-stage pump is used to supply fresh water under sufficient head to enter the exchanger during the first half of the cycle. Actually, this pump is a part of the plant water system. A second single-stage pump is required to boost the water pumped by the pressure exchanger against a net head equal to the head losses in the exchanger and piping plus the head corresponding to the height of the scrubber. A five-stage pump is required to pump a small quantity of fresh water directly to the scrubber to make up for losses by valve leakage in the exchanger. One small five-stage pump may be used to serve several units simultaneously. The total flow is normally controlled by regulating the pressure from the two single-stage pumps. The water level in the scrubber is controlled by regulation of the makeup from the five-stage pump.

The efficiency of the pressure exchanger, computed as the ratio of energy taken from the waste water to energy added to the fresh water, is good. Small losses occur as the result of hydraulic friction at various points, resistance of the diaphragm to flexure, valve leakage, and trapping of gas within the exchanger. For pumping any non-compressible liquid from 20 to 400 lb. per square inch, a well-designed exchanger should give 90 per cent efficiency.

The shape of the pressure exchanger and the method of valve operation may be modified from those illustrated. In some applications a cylindrical vessel of large capacity may be preferable. In this case the diaphragm is built in the form of a sack and secured in the center of the cylinder by a retaining ring. The valve timing may be synchronized directly with the diaphragm by use of a trigger mechanism making contact with the diaphragm at the ends of its stroke. This system is particularly applicable where delivery requirements are variable.

Protection against corrosion is made reasonably simple by the few moving parts and general accessibility. Proper choice of valve materials and coating of the interior of the pressure chamber will prevent attack by corrosion.

MULTI-WALL

These multi-wall paper bags containing 100 lb. of products arrived at destination in perfect condition, after a 1300 mile L C L trip which included several transfers in transit

PAPER BAGS are made in a large variety of constructions and sizes varying from the small single ply grocery bag to the large five or six ply sack holding 100 lb. There is an interesting story in the development of the many types of small bags used as shelf packages, how they have been made into display containers, improved in protective qualities and increased in strength, which we cannot cover at the present time. This article deals only with those multi-wall bags holding 50 lb. or more which are transported without the protection of an outer shipping container.

In approximately the last twelve years, heavy duty multi-wall paper bags have become so firmly entrenched in the rock products industry that these containers have largely replaced barrels and textile bags. Such substances are cement, gypsum plaster, lime and other materials which are shipped in large volume. These low priced products must be packed as reasonably as possible, handled at minimum cost, and can be shipped only relatively short distances. Therefore a set of standards of container strength and product protection have been formulated on these economic conditions.

This success led bag manufacturers to broaden the market for their containers in the food and chemical industries. With the problems of strength and protection solved, they put their efforts into building packing machinery which could handle substances of many differing physical characteristics. With the introduction of these machines in the process industries, they recommended bags of types which were standard in the rock products trades. Many chemicals are distributed nationally and internationally, and naturally they require stronger containers than those which are used for transporting materials only a few hundred miles. Many chemicals require more protection from contamination and from atmospheric conditions than cement, plaster and the like. Again bag manufacturers found that further container development was necessary. These factors naturally retarded the acceptance of the multi-wall bags. This has led, in the last few years, to a broader conception of the requirements by the bag makers and they have studied the packing and shipping requirements of each product under consideration as a new problem to be solved.

The chemical industry can profit greatly by a complete and exhaustive study of the equipment available for packing and closing paper bags along with the relative strengths of these sacks and the several types of protection which can be incorporated into them. There are possibilities of large savings in container and packing costs and the wide awake shippers are in a position to take full advantage of these opportunities as they present themselves.

The first step in the fabrication of multi-wall bags is to run the paper through a "tuber" which forms the tubes of the bag and folds in the gussets. In this operation a number of continuous sheets of paper, corresponding with the number of plies desired in the finished bag, are run through the tuber simultaneously. The several sheets are staggered and, as they pass over a former and are folded into tubular form, the opposite edges of each individual sheet are brought together and glued. The tube thus formed and consisting of several concentric plies of paper, then passes through rollers which press

PAPER BAGS

OFFER ATTRACTIVE OPPORTUNITIES

By R. W. LAHEY

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the tube flat. During this operation, each sheet of paper is properly tensioned both longitudinally and laterally so that each ply is of the proper size. This is of vital importance since each ply must take its share of the work in resisting strains and stresses in the finished bag.

The last of these operations is to cut the tube to the desired length. Open mouth bags which are to be sewed are cut straight while those of the valve type are cut with a notch in one corner which serves to form part of the valve in the subsequent valve forming operation. Bags which are to be pasted have a so-called "thumb" or semi-circular tab on one side of the bag. This allows fingers on the "bottomer" to properly fold the bag, for the automatic pasting.

Valve bags with pasted bottoms are made on double ending bottomers so that the valve is formed and both ends folded and pasted in one operation.

Sewed end bags are taped and sewed automatically by passing on a belt through a sewing head and tape applicator. If the bags are to be of the valve construction, the valve is first formed by folding and then both ends are closed by passing through sewing and taping machinery on each end of the tubes.

These machines are of ingenious and delicate mechanism and operate with unbelievable speed. The precision with which they operate gives the observer confidence in the unvarying quality of the containers which they produce.

Emptying a paper bag is a dustless operation and complete reclamation of contents may be obtained. Left—Illustrates proper method of handling bags. Note a brawny man is not needed. Below—Handling bags on an ordinary truck to which has been attached a wooden platform

Most bags are printed—this is done on a rotary press while the paper is in the roll. The press operates at remarkable speed and the results are extremely good considering the fact that rubber plates are used. Designs may be of from two to four colors and although rubber plates do not allow close registration many attractive and effective printing designs are in use. Rubber plates cannot print too fine or too sharp lines and bleeding of two colors should be avoided by the use of the natural paper outlines. Some particularly attractive designs are reproduced here to demonstrate what can be accomplished. These containers are always stored in piles and therefore the butts (ends) and gussets (sides) are the most important faces for printing.

If the product is ordinarily accompanied by a folder or tag containing directions, it is probable that all the data can be printed on the reverse side of the bag, thereby obviating the expense of the folder or tag. This will be especially appreciated by the production department whose responsibility it is to stock these instruction sheets and insert one in each container.

The introduction of the multi-wall paper bag into a new field probably requires more careful investigation and consideration than does the adoption of most other types of containers. To successfully devise a construction for this container, all of the following factors must be considered: 1. Filling equipment in use; handling, storing and loading conditions at the manufacturing plant. 2. Transportation by truck, rail C/L or L/C/L, boat. 3. Distribution—direct to consumer, or to warehouse. 4. Consumers handling and storing conditions and methods of dispensing. 5. Physical characteristics of the product. Pulverized materials absorb shocks whereas granular ones do not. 6. Required protection from contamination and from atmospheric conditions.

The interpretation of all of these data into a satisfactory and at the same time economical bag requires special skill and experience. Unless the prospective user has this knowledge he will be well advised to take advantage of the expert knowledge of most bag manufacturers. Unless this procedure is followed, costly errors are liable to result. The impression which an improperly packed trial shipment creates in the minds of customers is extremely hard to live down and it is therefore necessary that the initial shipments arrive in perfect

Construction of Multi-wall Paper Bags in Use

Commodity	*Weight packed pounds*	*Bag construction*
Aluminum sulphate	100	2/40–2/50*
Ammonium phosphate	100	4/40–1/50
Asbestos cement	50	1/50–1/60
Barium carbonate	100	3/40–1/50
Barytes (Barium sulphate)	100	2/40–2/50
Bone Meal	100	3/40–1/50
Calcium chloride	100	2/60–2/75 A.L.†–1/70
Calcium magnesium chloride	100	1/90 A.L.–3/40–1/50
Calcium phosphate	100	3/50
Casein	100	4/40–1/50
Cement	94	2/40–2/50
Cement	94	1/40–3/50
Cocoa	100	1/40–3/50
Corn starch	100	4/40–1/50
Copper sulphate	100	1/90 A.L.–3/50–1/60
Disodium phosphate	100	4/40–1/50
Dough improver	100	3/40–1/30–30 Sisal‡–1/50
Feldspar	100	3/40–1/50
Fertilizer	100	2/90 A.L.–3/50–1/60
Fertilizer	100	3/40–1/50
Fertilizer (Superphosphates)	100	1/90 A.L.–2/40–1/50
Filter clay	50	3/40–1/50
Fire clay	100	2/40–2/50
Flour	98	3/40–1/50
Flour	98	4/40–1/50
Glue	100	3/40–1/50–1/60
Graphite	80	2/40–1/50
Ground sulphur	100	4/40–1/50
Ground sulphur	50	2/40–1/50
Hydrated Lime	50	2/50
Hydrated Lime	40	1/40–1/50
Insecticides (Non poisonous)	50	1/90 A.L.–1/40–1/50
Limestone (Ground)	50	1/50–1/60
Limestone (Ground)	80	1/40–2/50
Limestone (Ground)	100	4/40
Lithopone	50	2/60–2/60
Manganese ores	100	4/40–1/50
Meat scrap	100	3/40–1/50
Pebble lime	80	1/70 A.L.–2/40–1/50
Phosphate rock	100	3/40–1/50
Plaster	80	3/40–1/50
Plaster	100	1/40–3/50
Quick lime	50	1/75 A.L.–1/40–1/50
Quick lime	80	1/40–1/75 A.L.–2/50
Rice	100	4/40–1/50
Rosin sizing	70	4/40–1/50
Salt	100	2/40–1/90 A.L.–1/40
Salt	100	3/40–1/50
Silica	100	3/40–1/50
Silica	50	2/40–1/50
Soda ash	100	4/40–1/50
Sodium bicarbonate	100	3/40–1/50
Sugar (Cane, beet, corn & grape)	100	4/40–1/50
Sugar (Granulated & powdered)	100	1/40–1/40 Wax§–3/40–1/60
Talc	50	1/50–1/60
Tankage	100	3/40–1/50
Whiting	50	2/40–1/50
Zinc oxide	50	2/50–1/60

Multi-wall paper bag handling requires somewhat different methods than textile sacks. This illustrates the proper method to use in lifting sewed end bags.

* The construction shows the number of plies and basis weight of kraft paper and reads from the inside ply out. Thus 4/40–1/50 means 4 plies of 40 lb. paper with an outside ply of 50 lb. paper.

The above types include valve and open mouth bags and both sewed and pasted end constructions. Open mouth bags are closed by wire tie, by sewing, and by sewing and taping. There are other constructions in use for the above products but the types listed are the most popular ones.

† A.L. indicates asphalt laminated sheet and the basis weight shown for the sheet includes the asphalt.

‡ 1/30–30 Sisal means 2 plies of 30 lb. kraft laminated with asphalt and sisal fibers.

§ 1/40 Wax indicates a 40 lb. kraft sheet waxed.

Basis weight is the weight of 480 sheets of paper measuring 24 in. x 36 in.

Most bags are printed—this is done on a rotary press while the paper is in the roll. The press operates at remarkable speed and the results are extremely good considering the fact that rubber plates are used

condition. The attending table showing bag constructions in use with the weights packed in them, the product carried and a notation of added protective features may prove helpful to the prospective user of these types of containers.

All multi-wall paper bags which are shipped by rail must meet the specifications listed in Rule 40, Section 10 of the Consolidated Freight Classification Committee. These regulations cover single wall, double wall and multi-wall bags.

The question of protection against the absorption of water vapor is a major consideration in choosing containers for some products. Multi-wall paper bag manufacturers are constantly searching for and testing new types of coatings and papers in an effort to improve this protection. Ordinary kraft paper is resistant to water and moisture to a considerable extent. The contents of a paper bag left in the field will probably not be damaged by a shower of rain, but if it remains in water for several hours, the bag will be penetrated and the product probably spoiled.

Water vapor is more difficult to control as it will permeate the tightest sheet of untreated paper. The fibers in paper are porous and therefore the only way to guard against this is to coat the paper or to apply a coating between two sheets of paper, called laminating. The moisture resisting material must be sufficiently flexible to withstand the folding operations of the bag making machinery. It must also be able to withstand low winter temperatures without cracking, and high summer temperatures without melting. Several types of materials have been used, the more important of which are asphalt and wax. Sheets of chlorinated rubber and moisture resisting transparent cellulose have also been used by laminating to paper with an adhesive or asphalt. These latter methods of protection are considerably more expensive and therefore limited in use.

Each shipper must make moisture transmission tests to determine the degree of moisture protection required. There are several short laboratory tests which will indicate the comparative resistance of different types of sheets such as the "densometer" test. The results cannot be entirely depended upon as they do not duplicate the conditions which the filled bags may encounter when stored in warehouses or in customers plants. The final and conclusive proof of the suitability of a container can

be arrived at only by testing bags which have been filled and closed under practical operating conditions and which have been subjected to handling and transportation abuses.

The salvage value of multi-wall paper bags depends largely on the previous contents, the care used in opening the bags, the quantity to be disposed of, and the nearness to waste trade centers. If bags are emptied in large quantities they can be baled and sold for waste paper or they may be opened carefully so that they can then be sold to local concerns for packing sand, coal, coke, clay and other similar materials. If desired, the outer printed wall of the multi-wall bag can be removed, leaving a plain container. Used paper bags cannot be employed as containers for rail shipment as they do not meet the Consolidated Freight Regulations but they are acceptable for truck movement.

The limiting factor in the re-use of bags by the small user, chiefly the farmer, is the character of the material which it originally carried. For instance, bags holding smelly fertilizer would probably be satisfactory as a roof sheathing paper for barns and chicken coops, but they would hardly be used to line the attic rafters of a dwelling. Some bags may be suitable containers for storage of bulbs, seeds, and even crops such as potatoes and apples.

Multi-wall paper bag handling requires somewhat different methods than the textile sacks. Two illustrations attached show first, the proper method to use in lifting sewed end bags and second, the proper way to carry these containers. It will be noted that the recommended method of carrying the bag is to hold it at diagonal corners so that the center of the bag rests against the stomach, to balance it and ease the strain. Hands should be used as hooks rather than to grip it. In picking up a bag by the end, never grip the corners as this is harder on the hands and has a tendency to tear the tape. Pasted end bags must be lifted by holding them at diagonally opposite corners.

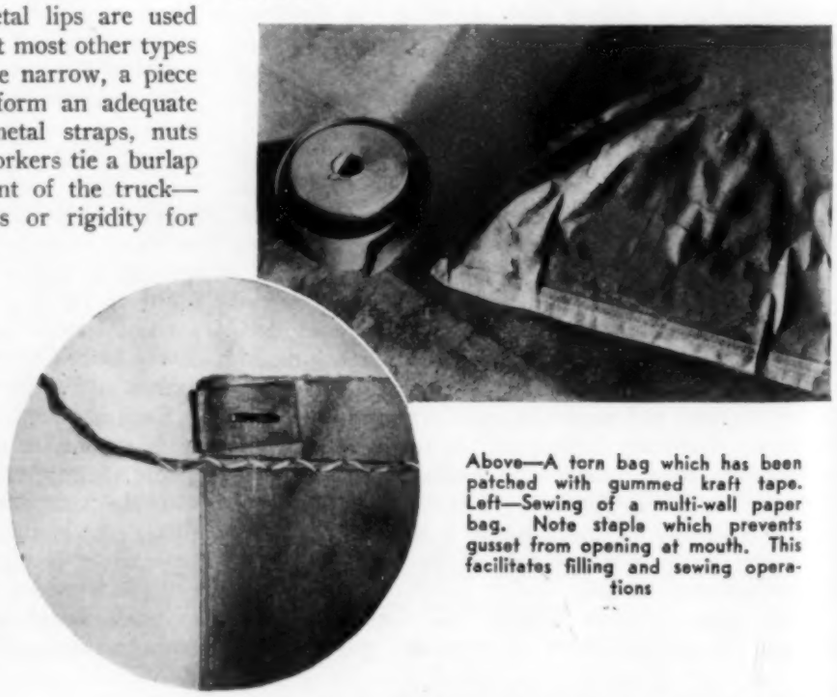
Special hand trucks with solid metal lips are used extensively for handling paper bags but most other types of trucks can be used. If the lips are narrow, a piece of wood can be easily fashioned to form an adequate platform. Wheel guards, exposed metal straps, nuts and bolts should be covered. Some workers tie a burlap bag or heavy cardboard over the front of the truck—the cover should have some stiffness or rigidity for adequate protection. This also applies to projecting metal hardware on auto trucks and wagons.

The use of slings to move bags into and out of freight vessels should be confined to the platform and canvas types. If the platform slings are used, the drafts should not be allowed to drag over or land on paper bags. A platform of dunnage should be fashioned into a landing place for the slings. Rope slings can be used only by the most experienced longshoremen and then only in an emergency.

The same careful preparations of freight cars which are used for textile bags should be employed for paper bags. All exposed nails should be removed and the floor should be covered with a good grade of car lining paper. Some shippers also line the side walls but this is not necessary if care is taken in the loading. There are many systems of car loading in use depending on bag size, number of bags to the car, size of the car, and distance of shipment. No universal loading method will serve in all instances but the best system for each condition can be determined by consultation with the bag manufacturers who will offer their expert advice. Some loading methods such as key stacking although effective, are costly, and it is quite probable that an economical straight pile scheme can be worked out which will prove as satisfactory. In general, the following basic principles should be used, but there is no guarantee against all conditions: 1. Stack so that ends of bags are parallel to car sides. This is most important on outside rows. 2. Step back rows at door ways to avoid door posts. This should be started two feet or more from door posts. 3. Outside rows should be a few inches from sides of car to avoid chafing and snagging. 4. Rows should be packed solid from end to end to minimize movement. 5. Bracing at doors does more harm than good and should be avoided.

Shipments in paper bags have been largely limited to carload movements but for a few years a small number of experienced shippers have been successfully transporting materials packed in specially constructed containers in L/C/L lots.

The multi-wall paper bag is relatively new in the container field but great strides have been made in a comparatively short time through the determination of the bag manufacturer to broaden his market. These containers are just entering the food and process industries and it will not be long before they are in great demand for packing powdered and granular foods and chemicals.



Above—A torn bag which has been patched with gummed kraft tape. Left—Sewing of a multi-wall paper bag. Note staple which prevents gusset from opening at mouth. This facilitates filling and sewing operations

Reciprocal Agreements Affect Foreign Trade in Chemicals

"FOR THE purpose of expanding foreign markets for the products of the United States . . ." the Tariff Act of 1930 was amended in June, 1934, to empower the President to enter into reciprocal agreements with foreign governments for the relaxation of tariffs and other trade restrictions. The reciprocal trade agreements program is being carried out by the Departments of State, Commerce, and Agriculture, the Tariff Commission, and other governmental units.

Up to the present, agreements with 14 countries have been completed and public hearings indicate that formal negotiations with 4 other countries are in progress. In 1935, the 14 countries with which agreements have been completed supplied approximately 40 per cent of domestic imports and took about 33 per cent of U. S. exports.

Many concessions accrue from extension to the United States of "most-favored-nation" treatment. For example, in the Canadian agreement, most of the concessions result from the shifting of the dutiable status of U. S. imports from the "general" to "intermediate" schedule of rates, which are the lowest at which non-Empire products may be entered.

With regard to customs administrative procedure, the U. S. has received important concessions through more favorable valuation methods, or through fixation of the bases on which duties are assessed, and through amelioration of regulations blocking exchange. Under some trade agreements, U. S. goods have been allotted increased quotas and in other cases minimum purchases have been guaranteed.

In connection with the reciprocal program, provisional agreements were completed in 1935 with the Soviet Union and Czechoslovakia. The Soviet Union, with a state monopoly of foreign trade, engaged to purchase from the United States $30,000,000 worth of goods within the 12 months following the signing of the agreement in July, 1935. In 1935, U. S. exports to the Soviet Union totaled about $25,000,000, an increase of 65 per cent over 1934. The provisional agreement with Czechoslovakia provided for most-favored-nation treatment as to tariff rates and equitable treatment in regard to foreign exchange control and other import restrictions.

For a few commodities, quotas were established to prevent undue increases in imports under the reduced duties. The reduced rates under all agreements, except that with Cuba, are applied to imports from all countries except Germany, from which country these benefits have been withheld following termination, in late 1935, of the most-favored-nation provisions of the treaty with the U. S.

Belgium—Belgium takes important quantities of American exports and in 1934, with purchases of $50,000,000, ranked ninth among this country's foreign markets. Trade concessions were granted to the U. S. on items which usually aggregate over one-third of our exports to Belgium. Duty reductions on most commodities range from 13 to 50 per cent and a number of rates are bound (or bound free). Other concessions comprise improved quota arrangements and the suppression or reduction of license and luxury taxes. Removal of the import quota and reduction of the license tax on linseed oilcake is a concession of considerable importance, as Belgium ordinarily purchases about 15 per cent of the total American output.

Brazil—Due to huge imports of coffee from Brazil, our trade balance with that country has been consistently unfavorable. Concessions granted to the U. S. include reduced or bound rates on over one hundred tariff classifications and special safeguards against such trade restrictions as import quotas, new import taxes, and exchange control.

Commodities on which Brazilian rates were reduced or bound represented about one-third of U. S. exports to Brazil in 1933. Particular importance may be attached to assurances by the Brazilian government that sufficient exchange will be provided for prompt payments on future imports, for the gradual liquidation of deferred commercial indebtedness, and the continued servicing of bonds held in the U. S.

Canada—Canada and the U. S. are each other's second largest export customers; in 1935 Canada supplied 14 per cent of imports into the U. S. and took 14 per cent of domestic exports. The commodities upon which concessions were granted amounted in 1930 (fiscal year ended March 31) to over 75 per cent of Canada's total dutiable imports from the U. S. Reductions granted range from about 8 to 25 per cent and in a few instances as high as 50 per cent. Concessions are of four different types: (1) Certain rates reduced and bound for the duration of the agreement; (2) classification for duty of all other U. S. products in the "intermediate" schedule of rates applicable to "most-favored-foreign-nations," (non-British countries); (3) a more favorable system of valuation for duty, and (4) benefits to commercial travelers and to transit trade through the U. S. As one result of the last named provisions, American commercial travelers may enter samples under bond instead of paying full duty without refund.

The sales tax, generally applicable to both imported and domestic products, was increased from 6 per cent to 8 per cent of the duty-paid value of the imported goods but there were important additions to the sales exemption list.

Cuba—Commodities on which principal concessions were gained represented approximately 45 per cent of total exports to Cuba in the years 1932–34.

Cuban tariff is highly complicated, with three schedules applicable to imports from different countries. Under the agreement, a number of duties were reduced. In addition, preferential rates granted to the U. S. made all duties on American goods at least 20 per cent and in some cases as much as 60 per cent less than the most favorable rates to other countries. Such preferences formerly ranged between 20 and 40 per cent but the basic rates were subject to change. When, in past years, certain Cuban tariff rates were increased to prohibitive levels or heavily reduced, the corresponding preferential rates to the U. S. became valueless. Rates on most items included in the agreement therefore were bound at specified levels.

In other concessions, Cuba clarified its customs nomenclature, made favorable adjustments in customs surtaxes, reduced internal taxes on many American products, agreed not to increase such taxes on certain other products; and (in July, 1935) reduced the consular invoice fee of 5 per cent ad valorem to 2 per cent. In many cases the internal taxes and other additional charges had constituted greater trade barriers than the customs duties.

Finland—Annual domestic exports to Finland have averaged about $6,000,000 in recent years. Concessions granted to

the U. S. comprised the reduction or binding of rates on 29 items which constitute a substantial proportion of this trade.

Imports of American lard, up to 2,200,000 pounds per year, will be dutiable at 4 marks per kilo, additional quantities at the old rate of 6 marks. The old rates were bound on gasoline (2 marks per kilo) and corn starch (1 mark per kilo).

France—France usually takes from 5 to 7 per cent of U. S. exports and ranks among the five leading foreign markets for American products. United States exports to France exceeded $265,000,000 in 1929 and totaled about $120,000,000 in each of the years 1931–35.

Principal concessions granted to the U. S. on specified commodities comprised: Reductions in 19 rates of duty; binding of a number of rates (usually already minimum rates); and liberalization of quota restrictions on 44 items. These concessions will benefit products representing about 21 per cent by value of France's total imports from the U. S. in 1935, or about 40 per cent of such dutiable imports.

General concessions of major importance comprised: The application to imports from the U. S., with a few exceptions, of the most favorable (minimum) tariff rates accorded to any country, affecting 4 per cent of the import trade with the U. S. (basis of 1934 statistics); agreement that all new quota allocations to the United States will be based upon the American share of importations in the years selected as a base period; reduction of the so-called "import turnover tax" heretofore 6 per cent (on manufactures) or 4 per cent (semi-manufactures) to 2 per cent, which is the rate applied to domestic sales of similar French products; this concession affects about one-third of the value of French imports from the U. S.

The French tariff contains some 700 or 800 chemical classifications, on about one-third of which U. S. products were formerly denied the minimum rates. Under the trade agreement, practically all of these items have been made dutiable at minimum rates, which are in many cases 50 to 75 per cent less than the rates formerly applicable.

Netherlands—The tariff rates of the Netherlands are low but an involved system of "crisis" trade controls has greatly restricted imports from the United States. The chief benefits gained for American exports are therefore in the form of bound rates of duty, liberalized quotas, and reduction or removal of import monopoly fees.

Sweden—The Swedish tariff is characterized by generally low rates and a large free list. Concessions affect many important export commodities, the total of which ordinarily amounts to some 60 per cent of our shipments to Sweden. Benefits gained for U. S. exports comprised duty reductions on 21 items and the binding of 43 existing rates, including 16 items on the free list. Products of the chemical process industries, on which concessions were obtained, accounted for over 25 per cent of total Swedish imports from the U. S. in 1933.

Switzerland—Switzerland's duties are low, but have provided the great bulk of the country's revenue. A complex system of import quotas and permits, adopted in 1931, imposed heavy restrictions upon imports from the U. S. which had ranged between 40 and 47 million dollars annually in the years 1927–30.

Analysis of Export Concessions Gained for Chemicals and Allied Products

Commodity Group[1]	Belgium	Brazil	Canada	Colombia	Guatemala	Cuba	Finland	France	Haiti	Honduras	Netherlands	Nicaragua	Sweden	Switzerland
Abrasives, artificial	.....	.....	RR	.....	.....	RR	.....	RB;Q	.....	RB	.....	.....	RB	.....
Adhesives	.....	.....	RR	RB	.....	RR;RB	.....	.....	.....	.....	.....	.....	.....	.....
Artists' colors	.....	.....	RR	.....	.....	RB	.....	.....	.....	.....	.....	.....	.....	.....
Baking powder & yeast	.....	.....	RR	RB	.....	.....	.....	.....	.....	.....	.....	.....	RR	.....
Coal-tar colors	RBF	.....	.....	.....	.....	RB	.....	RR	.....	.....	.....	.....	.....	.....
Coal-tar & derivatives	RBF	.....	.....	.....	.....	.....	.....	RR	.....	.....	.....	.....	.....	RB
Cements	.....	RR	.....	.....	.....	RR;RB	.....	.....	.....	.....	Q	.....	.....	.....
Disinfectants; insecticides	.....	.....	RR	RB	.....	.....	.....	RR	.....	RB	.....	.....	.....	.....
Electrodes	.....	.....	RR	.....	.....	.....	.....	.....	.....	.....	.....	.....	RB;RBF	RB
Explosives	.....	.....	RR	RB	.....	RR;RB	.....	RR	.....	.....	.....	.....	.....	.....
Cornstarch	RB;Q	.....	.....	RR	RB	RR	RB	RR	.....	.....	.....	.....	RB	.....
Fats & Oils														
Animal & fish oils, lard	RBF;Q	.....	RR	.....	RB	RR;RB	RB;Q	RR	RR[2]	.....	RBF	RR	.....	RR;Q
Vegetable oils	.....	.....	RR	.....	RR	RR;RB	.....	.....	.....	.....	.....	.....	.....	.....
Oilseed & copra cakes	RBF;Q	.....	.....	.....	.....	RR;RB	.....	.....	.....	.....	Q	.....	RBF	.....
Ferro-alloys	.....	.....	RR	.....	.....	.....	.....	RR	.....	.....	.....	.....	.....	.....
Fertilizers & materials	.....	.....	RR	.....	.....	.....	.....	RR	.....	.....	Q	.....	RBF	.....
Films; photo paper	.....	RB	RR	RR	.....	RR;RB	.....	.....	.....	.....	.....	.....	RB	.....
Glass and glassware	.....	.....	RR	.....	.....	RR;RB	.....	RR	RB	.....	.....	.....	.....	.....
Industrial Chemicals	RB	.....	RR	RB	.....	RR;RB	.....	RR;Q	.....	.....	.....	.....	.....	.....
Inks	.....	.....	RR	RB	.....	RR	.....	RR	.....	.....	.....	.....	.....	.....
Medicinal, chemicals or prep'ns	.....	.....	RR	RR;RB	.....	RR;RB	.....	RR	RR;RB	RB;RR	.....	RR;RB	.....	.....
Naval Stores	RBF	RR	.....	RB	.....	.....	.....	RR	.....	.....	RBF	.....	RBF	.....
Oilcloth & linoleum	RR	RR;RB	RR	RB	.....	RR;RB	.....	RR	.....	.....	.....	.....	.....	.....
Paints & varnishes	RR	RR	RR	RR	RR;RB	RR;RB	.....	RB;Q	.....	.....	.....	RR	.....	.....
Paper	.....	.....	RR	RB	.....	RR;RB	.....	RR;Q	.....	.....	Q	.....	.....	.....
Petroleum Products:														
Gasoline & kerosene	.....	.....	RR	.....	.....	.....	RB	.....	.....	.....	.....	.....	RB	Q
Lubricants	.....	.....	RR	RB	.....	.....	.....	.....	.....	.....	RBF	.....	.....	RB;Q
Paraffin	RBF	.....	RR	RR	.....	.....	.....	RR	.....	.....	.....	.....	.....	RB
Pigments	.....	.....	RR;RBF	RB	.....	RR;RB	.....	RR	.....	.....	.....	.....	RB	.....
Polishes; blackings	.....	.....	RR	RB	.....	RB	.....	RR	.....	.....	.....	.....	.....	.....
Rayon	.....	.....	RR	.....	.....	RB	.....	RR	.....	.....	.....	.....	.....	.....
Rubber products	RR	RR	RR	RB	RR	RR;RB	RR;RB	RR	RR[2]	.....	RB;Q	RR;RB	RR;RB	RB;Q
Salt	.....	.....	RR	.....	.....	.....	.....	RR	.....	.....	.....	.....	.....	.....
Soaps	.....	RR	RR	RR	.....	RR;RB	.....	RR	.....	RR	.....	.....	RR	.....
Sulphur	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	RBF	.....	RBF	.....
Toilet prep'ns; perfumery	.....	.....	.....	RR	.....	RR;RB	.....	RR	.....	.....	.....	.....	RR	.....
Effective date of agreement	May 1, '35	Jan. 1, '36	Jan. 1, '36	May 20, '36	Pending	Sept. 3, '34	Pending	June 15, '36	June 3, '35	Mar. 2, '36	Feb. 1, '36	Pending	Aug. 5, '35	Feb. 15, '36
Duration of agreement (unless; extended)	Indefinite	2 years	3 years	2 years	3 years	3 years	3 years	12½ mos.	3 years	1 year	2 years 11 mos.	3 years	3 years	3 years

SYMBOLS: RR = Rate reduced; RB = Rate bound; RBF = Rate bound free; Q = Quota increased or guaranteed.
[1]The trade agreements include only selected items from each group. [2]Conditional.

Chemical Engineer's BOOKSHELF

Old Man Corrosion

CORROSION RESISTANCE OF METALS AND ALLOYS. By *Robert J. McKay* and *Robert Worthington*. Published by Reinhold Publishing Co., New York. 455 pages plus 38 of index. Price, $7.

Reviewed by *James A. Lee*

THIS IS a volume that should be added to every chemical engineer's bookshelf on materials of construction. It is chuck full of information that is sure to come to the rescue the next time corrosion develops. Messrs. McKay and Worthington have had long experience with corrosion problems and had a vast amount of valuable material upon which to draw in the preparation of this book.

The engineer who has the problem of making a piece of equipment last as long as possible in corrosive conditions, should have a general knowledge of how corrosion works. For this purpose the first 100 pages have been devoted to the general and theoretical phases of the subject. In this section the authors have discussed such factors dealing with the rate of corrosion as: movement, electrolytic effects, solid films and temperature. They also covered forms of corrosion, corrosives, and corrosion properties of metals.

The other part of the volume deals with the corrosion behavior of specific metal and alloy groups. A chapter is devoted to each group. The general corrosion resistance of the base metal and its alloys have been discussed followed by the effect of a dozen or more of the most commonly met with chemicals and gases, and high temperatures. Many references are given throughout for the benefit of the engineer who wants to secure more information on any particular point under discussion. And to each chapter is attached a very complete bibliography.

If any fault is to be found with this splendid work, it is due to the omission of a chapter on silver and the rare metals. It would seem that this subject is more important from the viewpoint of the chemical engineer than one or two of those that have been included. Then too we would like to have seen more information regarding some of the newer products, such as tellurium lead, the effect of additions of columbium, nitrogen and titanium on the grain growth of steels and how the introduction of nitrogen to chromium-nickel steels affects machinability and strength.

Numerous tabulations of chemical and physical data, and many diagrams are included to supplement the discussion. A complete author and subject index bring the book to a close.

SURVEY OF THE BIOCHEMICAL ACTIVITIES OF THE ACETIC ACID BACTERIA. By *K. R. Butlin*. Published by British Library of Information; London, 1936. 47 pages. Price, 35 cents.

THIS BOOKLET is Special Report No. 2 of Chemistry Research published by the British Department of Scientific and Industrial Research. It reviews the potential capabilities of acetic acid bacteria in organic synthesis and oxidation processes that may lead to important industrial applications, and, eventually, touches also upon other fundamental biologic problems.

Kinks

WORKSHOP RECEIPTS (5 Vols.)—Distributed in United States by Chemical Publishing Co. of N.Y., Inc., 148 Lafayette St., New York. Each volume over 500 pages. 5½ x 8 in. Cloth. Indexed. Price, $2.50 per volume.

NO ONE can be a specialist in every field, but often someone hopes a book will turn out to be. Requests for information on how to do and how to make all sorts of queer things come up all day long, and often are difficult to answer readily. These books, standard in England for some years, have just been introduced into the United States. They detail processes, formulas, methods and just plain "kinks" by the hundred, arranging them alphabetically in four volumes. The fifth is a supplement including more recent data and filling gaps in the earlier ones. If you want only one book, the supplement is the one to choose.

Subjects of interest to chemical engineers include: acidimetry, aerating agents, albumen, alcohol, alcoholimetry, alkaloids, alloys, aluminum, belting, bleaching, distilling, disinfectants, drying and desiccating, etc., as a sample from the first volume alone.

Clayton Up-to-Date

THEORY OF EMULSIONS. By *William Clayton*. Published by P. Blakiston's Son & Co., Philadelphia, Pa. 458 pages. Price, $8.

Reviewed by *W. L. Abramowitz*

THIS THIRD EDITION of Clayton's is a welcome addendum to the literature of emulsions. Completely revised, it offers a solid yet lucid presentation of the subject and should prove, in spite of the title, to be of wide, practical utility.

The text may be considered divided into three parts; the physical chemistry and theoretical aspects of emulsions, emulsifying agents and the various industrial phases of emulsions, the preparation of emulsions both in the laboratory and commercially. The last contains a survey of modern methods and machinery. To cite but a few of the important technical topics treated: bituminous emulsions, sulphonated oils, edible emulsions, fat-liquoring of leather, soaps, and textile assistants. An excellent chapter on deemulsification discusses the mechanical, chemical, and electrical processes in use with special references to crude oil emulsions.

The literature both scientific and patent is admirably summarized, an appendix in addition listing an extensive array of deemulsification patents. This feature will be of particular interest to the industrial chemist. The book is earnestly recommended.

Physico-Organic Chemistry

PHYSICAL ASPECTS OF ORGANIC CHEMISTRY. By *W. A. Waters*. Introduction by *Prof. T. Martin Lowry*. Published by D. Van Nostrand Co., Inc., New York City. 483 pages. Price, $9.50.

Reviewed by *William Abramowitz*

THIS VOLUME, planned jointly by Prof. Lowry and Dr. Waters and completed by the latter, marks a high point in the summation of the authors' interest in the electronic mechanism of organic reactions. Recognizing as a conspicuous feature of modern organic chemistry the attempt to apply the physical concepts of electronic, atomic, and molecular structure to explain and predict reactions, Dr. Waters prefaces the chemistry with a rapid yet thorough description of sub-molecular phe-

nomena. Upon this as a foundation he then traces the course of reactions to the electronic structure of the molecule and ultimately to the electronic configuration of the component atoms.

A general outline of theoretical organic chemistry is offered with the evident intention of surveying a wide range of theories rather than of devoting particular stress to a few specialized themes. The material is, however, by no means treated superficially. There are excellent chapters on electrical properties of the molecule, esterification, reactions of unsaturated linkages, and configurations of aromatic compounds. The subject matter is admirably referenced. In a field still obscure with conflicting theories, the clarity and facility of presentation of this work render it especially valuable to research chemists seeking an insight into the "whys" of organic chemistry.

Power Trends

LIVING TOGETHER IN A POWER AGE. By *Samuel S. Wyer.* Published by Associated Press, 347 Madison Ave., New York City. 231 pages. Price, $2.50.

THIS VOLUME is an odd mixture of statistical matter and philosophic discussion. It represents a very interesting and attractively presented résumé of the trends in the development of energy supplies and the relations of these to human affairs generally. From such quasi-technical base the author leads on to a presentation of his philosophy of industrial and social progress. Although in some measure useful as a reference book, the volume is primarily an effort in propaganda for sane treatment of power projects and progress toward a higher civilization which should be reached, according to this author, by his "New Decalog for Human Welfare," the peroration of the book.

Gas Well Yields

BACK-PRESSURE DATA ON NATURAL-GAS WELLS AND THEIR APPLICATION TO PRODUCTION PRACTICES. By *E. L. Rawlins* and *M. A. Schellhardt.* Bureau of Mines Monograph No. 7, published by the Bureau in cooperation with the State of Oklahoma and the Natural-Gas Department of the American Gas Association. 210 pages. Available for purchase only from American Gas Assn., 420 Lexington Ave., New York City. Price, $1.50.

GAGING of underground conditions in natural gas wells and the application of gage data for better production practice was the objective of an extended research which has covered several years. The results are presented in this volume, which has great importance for any division of process industry concerned with the supply of natural gas or the production of industrial products therefrom.

Recent German Books of Chemical and Metallurgical Interest

SCHWEFEL. By *Erich Thieler.* Published by Verlag von Theodor Steinkopff, Dresden and Leipzig, 1936. 136 pages. Price, paper bound RM.8.—

Reviewed by *Walter Bloch-Hiller*

THIS MONOGRAPH is volume 38 of a series of progress reports on chemical technology edited by Prof. Dr. B. Rassow of Leipzig. The author reviews all the problems pertaining to elementary sulphur, their chemical, technological and economic aspects as well as the competitive struggle between natural and byproduct sulphur; this latter phase being of special importance in Germany. Numerous references to patents and literature are included.

DER AUFBAU DER ZWEISTOFFLEGIERUNGEN. By *M. Hansen.* Published by Verlag von Julius Springer, Berlin. 1,100 pages. Price, RM. 87.

AN IMPORTANT volume this, as the number of pages alone would indicate. Dr. Hansen who was a member of the Kaiser Wilhelm-Institute of Metallurgy, Berlin-Dahlem, assembled all available information regarding binary metal alloys thus making it possible for the reader to avoid perusal of the many original publications. The diagrams are complete as far as present knowledge permits, no hypothetical lines being added. Literature up to the end of 1935 has been reviewed and is listed at the end of each paragraph. Print and paper correspond to the high standard set by Springer. This work should be of great value to the metallurgist.

FLUSSAURE, KIESELFLUSSAURE UND DEREN METALLSALZE. By *Dr. Oscar Kausch.* Published by Verlag von Ferdinand Enke, Stuttgart. 438 pages. Price, RM. 23.80.

DR. KAUSCH, an official of the German patent office, has attempted to give a complete review of the characteristics, production and utilization of hydro- and silico-fluoric acid and their metallic salts. Thirty-six pages are devoted to literature references, ten pages to patent listings besides a detailed index.

Gas Report

AMERICAN GAS ASSOCIATION PROCEEDINGS, 1935. Published by the Association, 420 Lexington Avenue, New York City. 846 pages. Price, $3 to members, $7 to nonmembers.

ANNUALLY in this series are accumulated some of the outstanding technical and economic reports on the manufactured and natural gas industry of the country. Anyone who pretends to have a complete library on fuels, needs these volumes as they represent a compilation of technical literature not to be found elsewhere.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Changes in Import Duties Since the Passage of the Tariff Act of 1930. Tariff Commission, Miscellaneous Series, Second Edition, June 1, 1936; 10 cents.

The Trade Agreement With Canada. Tariff Commission Report No. 111, 2nd Series; 15 cents. Summary of provisions of the agreement, and of the trade statistics relating to the commodities affected by it.

Organic Plastics, by Gordon M. Kline. Bureau of Standards Circular 411; 5 cents. A survey of their sources, properties, and uses.

Report on Production, Sales, Imports, and Exports of Coal-Tar Crudes, 1935. Tariff Commission release June 27, 1936; mimeographed.

Production and Sales of Organic Color Lakes and Toners in the United States, 1935. Tariff Commission release of June 4, 1936; mimeographed.

United States Rubber Consumption and Year-End Stocks, 1935. Bureau of Foreign and Domestic Commerce, Supplement to Rubber News Letter Special Circular No. 3607; mimeographed, 10 cents, (available from Bureau only).

Tung Oil, by C. C. Concannon. Bureau of Foreign and Domestic Commerce Trade Promotion Series 133; 10 cents. Economic and commercial factors in the development of a domestic tung oil industry.

Fats and Oils, and the Excise Taxes of 1934. Bureau of Agricultural Economics; mimeographed.

Oil Yield and Oil Content of Certain Oleaginous Materials, by Anne Dewees. Bureau of Agricultural Economics; mimeographed.

Specifications for the Denaturants Authorized for Completely Denatured Alcohol. Treasury Department AT Circular No. 182, June 8, 1936; mimeographed.

Authorizing Completely Denatured Alcohol Formulae 11, 12, and 13. Treasury Department, Treasury Decision 4648, approved June 3, 1936; mimeographed.

Unit Weights of Materials Adopted by the Navy Department for Purposes of Estimate and Design. Navy Department, unnumbered pamphlet, March, 1936 edition; 5 cents.

Phosphate Rock Near Maxville, Philipsburg and Avon, Montana, by J. T. Pardee. U. S. Geological Survey Bulletin 847-D; 20 cents.

Concentration of Copper Ores in North America. Bureau of Mines Bulletin 392; 15 cents.

Microcolorimetric Determination of Benzene in Blood and Urine, by S. J. Pearce and others. Bureau of Mines Report of Investigations 3302; mimeographed.

Lime, by Oliver Bowles and D. M. Banks. Bureau of Mines Information Circular 6884; mimeographed.

Comparison of Output and Intake Characteristics of Natural-Gas Wells in Texas Panhandle Field, by M. A. Schellhardt and E. L. Rawlins. Bureau of Mines Report of Investigations 3303; mimeographed.

Mineral Production Statistics—Separate statistical appendices to 1935 Minerals Yearbook giving detailed statistics on: Coal, by W. H. Young and others; Crude Petroleum and Petroleum Products, by G. R. Hopkins

and A. B. Coons; Gold and Silver, by J. P. Dunlop; 5 cents each.

Mineral Production Statistics for 1935—preliminary mimeographed statements from Bureau of Mines on: Carbon black; asbestos; potash; asphalt; tungsten; molybdenum; bauxite; pyrites; mercury; abrasive materials; platinum and allied metals; sales of liquified petroleum gases.

Federal Specifications. New or revised specifications of the Federal Specifications Board on: Wax, floor, liquid and paste, P-W-141; Road and Paving Materials, general specifications (methods for sampling and testing), SS-R-406, 10 cents; Paint, cold-water, casein-binder, light tints and white, TT-P-23; 5 cents each except where otherwise specified.

Biennial Census of Manufactures, 1933. Bureau of the Census, 663 pages, cloth bound; $1.25. Gives statistics for industries by groups.

Rayon and Allied Products. Bureau of the Census, Census of Manufactures, 1935; mimeographed.

Production and Sales of Dyes and Other Synthetic Organic Chemicals in the United States, 1935. Tariff Commission release June 4, 1936; mimeographed.

RECENT BOOKS AND PUBLICATIONS

Reports of the Progress of Applied Chemistry, Vol. XX, 1935, issued and published by the Society of Chemical Industry, London, 1936. 814 pages. A comprehensive review of the progress achieved in chemical industries of the world; reference notes and a complete index make the volume valuable for research and investigation.

Organic Syntheses, Vol. XVI, edited by J. R. Johnson, published by John Wiley & Sons, Inc., New York, 1936. 104 pages. Price, $1.75. The 1936 edition of this well known annual publication reporting new methods for the preparation of organic chemicals.

Organic Chemistry, by James Bryant Conant. Revised edition. Published by The MacMillan Co., New York, 1936. 293 pages. Price, $2.60. With the assistance of Dr. Max Tishler the first edition of 1928 has been revised. The introduction to the subject by means of the alcohols, instead of the hydrocarbons, has been retained. This textbook seems especially useful for those desiring a comprehensive but elementary course in organic chemistry.

The Chemistry of Milk, by W. L. Davies. Published by D. Van Nostrand Co., Inc., New York, 1936. 522 pages. Price, $8. Dr. E. Howard Tripp has assumed the editorship of a series of monographs on applied chemistry, this work being volume 10. The author attempts to gather in concise form all that is actually known about the chemistry of milk, thus making his work valuable to chemists, physiologists and the medical profession. A section is included covering the technological aspects.

The Chemistry of Natural Products Related to Phenanthrene, by L. F. Fieser, published by Reinhold Publishing Co., New York, 1936. 358 pages. Price, $6.50. This is an American Chemical Society monograph issued by the successor to the Chemical Catalog Co., Inc. During the past six years, almost dramatic disclosures have been made in this particular field, with its increasing importance on biochemistry (investigating cancer, hormones and so on). Literature up to February 1936 has been reviewed, thus assembling all the data available and preparing the ground for further research centering on synthesizing in this complex field.

The Student's Manual of Microscopic Technique, by J. Carroll Tobias. Published by American Photographic Publishing Co., Boston (Mass.), 1936. 210 pages. Price, $2.50. The object of the author was to provide the amateur with a textbook enabling him to enjoy his hobby, showing him where to go for material and what to do with it. It reaches its climax with a chapter on photomicroscopy. A large number of good reproductions and a page of bibliography are inducements for more advanced study.

The Chemical Formulary, Vol. III, by H. Bennett. Published by D. Van Nostrand Co., Inc., New York. 1936. 566 pages. Price, $6. Owing to the great number of new ideas, methods and improvements made continuously, the publication of this addition to the two volumes issued previously has been made necessary, at the same time increasing the usefulness of this important work considerably. Trade named chemicals, a manufacturer's list and a detailed index covering all three volumes complete this edition.

I. Smokeless Briquets: Impacted without Binder from partially volatilized Illinois Coals and II. Smoke Index: A quantitative measurement of Smoke, by R. J. Piersol, Report of Investigations—No. 41, Illinois State Geological Survey, Urbana, Ill., 1936, 113 pages. This is a further preliminary report on utilization of Illinois coal describing laboratory investigations.

Industrial Research—The facilities offered at the Ohio State University. A pamphlet recommending its facilities of research to industrial concerns.

Directory of Members of the Association of Consulting Chemists and Chemical Engineers, Inc., New York. 2nd edition, April 1, 1936.

Flow Sheets of Process Industries, by editors of Chem. & Met., Second edition, revised and enlarged. Published by Editorial Department, Chemical & Metallurgical Engineering, McGraw-Hill Building, New York, 1936. 103 pages. Price, $1. By adding enlarged copies of 37 recently published flowsheets to the older book, a total of 100 is now available in 8½x11 in. size reprinted on heavy white paper with special index cover and spiral wire binding. A unique supplement is also available at 50 cents per copy which will enable owners of the older edition to bring their flowsheet collections up-to-date.

Solutions of Electrolytes, by Louis P. Hammett. 2nd edition. Published by McGraw-Hill Book Co., Inc., New York, 1936. 238 pages. Price, $2.25. Progress in technique and experience in the use of this textbook have prompted the author to revise the first edition of this volume to great advantage.

The Structure of Metals and Alloys, by William Hume-Rothery. Institute of Metals Monograph and Report Series No. 1, published by the Institute of Metals, London, 1936. 120 pages. Price, 3 sh. 6 d. Following other professional associations, the British Metal Institute is inaugurating with this volume a series of monographs. This book is not intended as a complete review of the subject but wants to throw light on the fundamentals by selection of certain subjects which has been most happily achieved.

Perfumes, Cosmetics & Soaps, by William A. Poucher. Vol. I, Dictionary of raw materials with an account of the nomenclature of synthetics. Fourth edition, published by D. Van Nostrand Co., Inc., New York, 1936. 439 pages. Price, $8. Further evolution in the art of perfumery raw materials have called for a new edition of this widely known work bringing it again up-to-date.

Chemical Discovery and Invention in the Twentieth Century, by Sir William A. Tilden. Sixth edition, revised by S. Gasstone. Published by E. P. Dutton & Co., New York, 1936. 492 pages. Price, $4. This is a completely revised edition, obsolete sections having been discarded, new subjects included such as nitrogen fixation, rubber synthesis, transmutation of elements and so on. It should appeal equally well to the layman and to the technician desirous of information in other branches.

The Romance of Chemistry, by William Foster. Second edition, published by D. Appleton-Century Co., Inc., New York, 1936. 497 pages. Price, $3. Ten years of progress have necessitated in this case as well a revised and enlarged edition, including such late topics as "heavy water," recent vitamin research, liquefaction of coal and so on.

La Società Montecatini ed il suo Gruppo Industriale, published by Società Montecatini, Milan (Italy), 1936. 636 pages. This big volume, profusely illustrated, has been published by the staff of the largest Italian chemical concern in honor of the twenty-fifth anniversary of the presidency of Ing. Guido Donegani. It gives a complete picture of the development and activities of this complex group, and the importance it has gained under the direction of Mr. Donegani.

Society of Chemical Industry. (CIBA), Basel (Switzerland)—1884 to 1934. Published by CIBA, Basel, 1935. 85 pages. The well known Swiss concern published a handsome book with numerous multicolored engravings in commemoration of its 50th anniversary describing the development of this important Swiss export industry in relation to general economic conditions as well as scientific and industrial progress.

Fabrikation von absolutem Alkohol zwecks Verwendung als Zusatzmittel zu Motor-Treibstoffen, by M. Klar. Published by Verlag von Wilhelm Knapp, Halle (Saale), Germany, 1936. 84 pages. Price, paper bound, RM.4.20. Germany, as do many other countries in Europe, requires an admixture of alcohol to motor car fuel in order to assist the farmer and to utilize domestic products in preference to imported material. This booklet gives a concise review of the art of producing absolute alcohol including bibliography, patent review and cost of production in Germany.

Grundriss der Chemischen Technik, by Dr. F. A. Henglein. Published by Verlag Chemie, G.m.b.H., Berlin (Germany), 1936. 470 pages. Price, RM.16.80. Dr. Henglein has written the first officially recognized German textbook for chemical engineers. Almost 300 illustrations assist the student to visualize the text, all of which are most carefully prepared. As more universities adopt chemical engineering courses, this work will be of considerable value to students and even recent graduates.

No. 267—Thixotropy, by H. Freundlich (in English). 50 pages. Price, Fr. 12.

No. 272—Recherches Analytiques sur l'Arginine et L'Histidine by Jacques Bussit (in French). 100 pages. Price, Fr. 20.

No. 275—L'Action Chimique des Rayons Alpha en phase gazeuse, by W. Mund (in French). 51 pages. Price, Fr. 15.

No. 276—Les Thermostats pour les température moyennes, by André Lalande (in French). 52 pages. Price, Fr. 15.

No. 298—Contribution à l'étude de la Constitution de l'Amidon, by R. Sutra; 62 pages. Price, Fr. 15.

No. 309—Activité et Interaction Ionique, 1st part: Exposé Théorique, by M. Quintin; 33 pages. Price, Fr. 8. These monographs are published under the title "Actualités Scientifiques et Industrielle" by Hermann & Cie., Publishers, Paris. The titles listed above appeared in 1935. Every section of the entire field of science is covered, and each one is under the supervision of an eminent authority.

Cutting costs with liquid caustic soda. Prepared with the cooperation of Walter L. Savell and others of the technical staff of the Mathieson Alkali Works. 66 pages. A thorough economic and engineering study of the properties of caustic soda in its aqueous solution, advantages in their handling and use, together with recommended methods for accurate sampling and analysis of caustic liquors. A commendable example of a new type of technical trade literature of value to all production men in process industries.

Cumulative Index of Metallurgical Abstracts, Metals & Alloys. January to December, 1935. Published by Reinhold Publishing Co., New York. 69 pages. Price, $2. The index is divided into the usual two sections: subjects and authors. These refer to the 5233 abstracts appearing in Metals & Alloys during the year 1935. Over 800 domestic and foreign publications were covered by the abstractors.

Your Plant NOTEBOOK

NOMOGRAPHIC CHART FOR LOGARITHMIC MEAN TEMPERATURE DIFFERENCE

By E. L. McMillen
Iowa State College
Ames, Iowa

IN COMPUTATIONS dealing with heat transfer from one fluid to another in such equipment as heat exchangers, condensers, tempering coils and the like, the proper driving force to use is the logarithmic mean of the terminal temperature differences,

$$\Delta t_m = \frac{\Delta t_2 - \Delta t_1}{2.3 \log \frac{\Delta t_2}{\Delta t_1}}$$

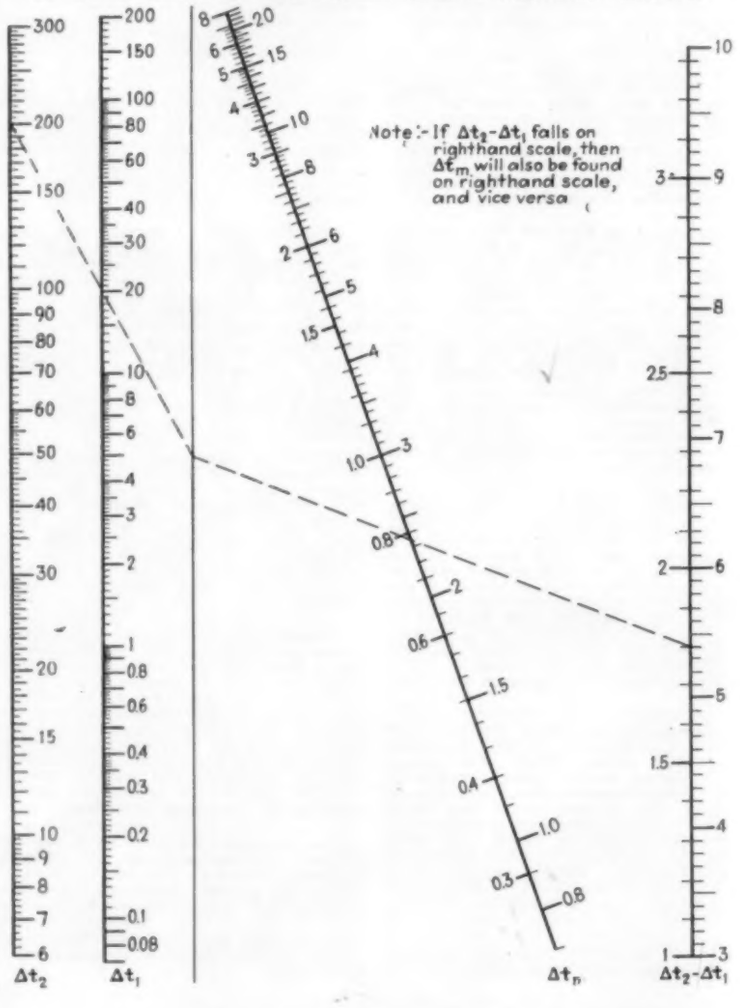
Use of this equation becomes quite tiresome, since several settings on the slide rule are required to solve for Δt_m, the logarithmic mean. A more direct means for finding Δt_m would save considerable time and effort. To fill this need the accompanying nomographic chart was constructed. Previous charts have yielded the logarithmic mean with considerable inaccuracy* and have covered only a limited range.†

The present chart consists of a logarithmic alignment chart on the left together with a Z or N chart on the right, both sharing the unscaled central reference line. While the nomograph apparently is limited to the range of Δt_2 from 6 to 300 deg. and Δt_1 from 0.07 to 200 deg., in reality it is limited only by the fact that Δt_2 may not be more than 100 times as great as Δt_1. The decimal point for Δt_2 may be moved either to the right or left any number of places, provided the same shift is made for Δt_1. Thus the case illustrated, where $\Delta t_2 = 200$ deg. and $\Delta t_1 = 20$ deg., could equally well be $\Delta t_2 = 2{,}000$ deg. and $\Delta t_1 = 200$ deg. Their quotients are the same and locate the same point on the central reference line. The chart has also been limited to the region where Δt_1 is less than 67 per cent of Δt_2, since when Δt_2 and Δt_1 become that nearly equal the arithmetic average is sufficiently accurate.

It will be noted also that the two $(\Delta t_2 - \Delta t_1)$ scales cover the range of values from 1 to 10 while the Δt_m scale covers the range from 0.3 to 20. The operator is expected to shift the decimal point mentally to correspond to the case in hand. Thus, in the case illustrated, $\Delta t_2 - \Delta t_1 = 180$, so the operator locates the point 1.8 and mentally shifts the decimal point two places to the right. Since he used the left hand scale for $\Delta t_2 - \Delta t_1$, he should also read the left hand scale for Δt_m. The scale reads 0.782 and the operator mentally moves the decimal point the same distance as upon the $(\Delta t_2 - \Delta t_1)$ scale to get 78.2 as the log mean of 200 and 20. If the right hand scale is used for $\Delta t_2 - \Delta t_1$ then the right hand scale for Δt_m should also be used. The same shift in the decimal point should always be used for Δt_m that is used for $\Delta t_2 - \Delta t_1$. Under these circumstances it is readily seen that the range of the nomograph is limited only by the fact that Δt_2 must be less than 100 times Δt_1.

The logarithmic mean radius is used in calculating resistance to heat flow in a radial direction in a case such as a steam pipe insulated with magnesia or

Nomograph for determining logarithmic mean temperature difference



* Bulletin 1651, p. 28, The Griscom Russell Co., New York, 1929.
† Anon., *Combustion*, p. 43, Nov., 1931; also Hewes and Seward, "The Design of Diagrams for Engineering Formulas and The Theory of Nomography," p. 63, McGraw-Hill Book Co., New York, 1923.

other material of low thermal conductivity. In gas absorption calculations, when the solution of gas in absorbing liquid obeys Henry's law, it is permissible to use as the driving force in the rate of absorption equation the logarithmic mean of the two terminal driving forces. These may be expressed as pressure difference (p), concentration difference (c), in terms of pounds of adsorbable gas per pound of inert gas (y), or in terms of pounds of absorbed gas per pound of absorbing liquid (x). In humidifier calculations the logarithmic mean humidity difference is sometimes used to calculate spray chamber volumes. In any case such as these where the logarithmic mean of any two quantities is required it can be obtained by the use of this nomograph, merely by relabelling the scales to correspond to the desired case and by proper shifting of the decimal points to cover the range desired.

Quick Acting Closure for Pressure Vessels

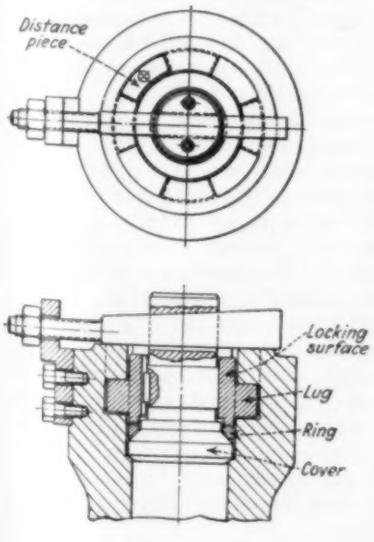
By F. G. Laupichler
Consulting Engineer
Salzburg, Austria

IN COMMERCIAL operation of high pressure autoclaves and converters it is rarely necessary to remove the head of the vessel. In laboratory and semi-works investigations, however, the case is different and frequent opening of the vessel is necessary, both for inspection of the interior and for changing the filling, such as catalysts, packing rings, etc. Hence a vessel of the latter type requires a specially designed closure which not only can be removed and replaced with the least expenditure of time and effort but can also be made absolutely tight despite frequent openings.

The closure described below has been designed to overcome the objections to earlier types and to make and preserve a gas tight joint without the need for close machining. It can best be described in connection with the drawing. In the lower (elevation) view it is evident that the seal is effected between a truncated surface of the cover, a softer metal ring and the wall of the vessel itself and that the connection is drawn tight by the pressure of the gas within the vessel which forces the cover against the ring. The latter in turn is wedged against the slightly conical vessel wall and against an annular locking piece or surface provided with four lugs serving as a sort of bayonet lock. Corresponding lugs in the vessel body take the upward thrust of the locking surface.

The joint is made by inserting the cover, ring and locking piece, and turning the latter through 45 deg. to engage the lugs. A distance piece is then inserted to prevent further turning. Initial closure is effected by inserting the wedge in the cylindrical portion of the cover and using it to pull up the cover to make an easy joint with the ring. As soon as gas pressure is applied the joint then automatically tightens as much as necessary.

Plan and elevation of closure for experimental pressure vessels



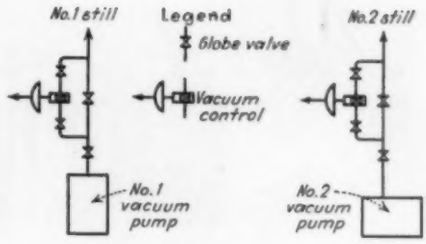
New Hookup Successful in Vacuum Distillation

By Sydney Steele
Industrial Engineering Division
E. I. du Pont de Nemours & Co.

NOT LONG AGO a vacuum still (No. 3) was installed in a building where there were already two others, hereafter referred to as Nos. 1 and 2. No. 1 had twice the capacity of Nos. 2 and 3, and was equipped with a 10-hp. vacuum pump; No. 2 had a 5-hp. vacuum pump, and both pumps were electrically driven. The arrangement is shown diagrammatically in Fig. 1.

At first thought it was planned to install a new 5-hp. vacuum pump for the new No. 3 still. Further investigation showed, however, that after vacuum was established the volume of inerts to be dealt with was so small that the small pump on No. 2 still would handle the load of all three stills. In addition, very little floor space was available for additional pumping equipment.

Accordingly the arrangement shown



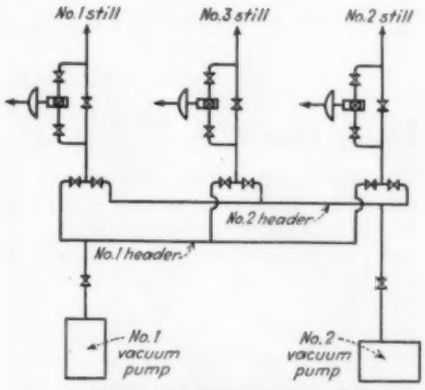


Fig. 1, Above—Old arrangement with two stills separately exhausted

Fig. 2, Below—New arrangement with three stills interconnected to two vacuum pumps

diagrammatically in Fig. 2 was adopted and is giving satisfactory service. Each pump exhausts its own header, and each still can be operated from either or both headers at will. Under normal conditions No. 2 pump is used to operate all three stills.

The following advantages are obtained:

1. The capital cost, various charges, and maintenance of a new vacuum pump, motor and starting equipment, and so on, are saved.
2. No additional floor space is occupied in an already crowded building.
3. By running both pumps simultaneously, any still, operated from both headers, can be exhausted to operating vacuum in 30 to 60 per cent of the time formerly required.
4. After vacuum is established, the load of any number of stills can be carried on No. 2 pump. This is estimated to have cut the power costs by 60 per cent.
5. Any still can be brought to operating vacuum without disturbing the others, by utilizing No. 1 pump and its header. Thereafter this still can be transferred to No. 2 header, and No. 1 pump shut down.
6. Except for the short time required to establish vacuum on a still while another is running, either No. 1 or No. 2 pump can be regarded as standby equipment. Under the original arrangement, with only two stills, this factor of safety was not immediately available.

News of EQUIPMENT

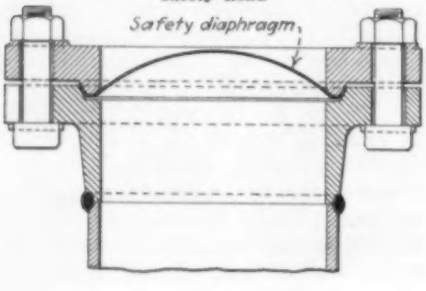
Safety Heads

Safety heads for a wide variety of pressures, made in a considerable number of corrosion resisting metals, are now available from Black, Sivalls & Bryson Mfg. Co., Kansas City, Mo. The heads are spherical drawn diaphragms which are secured in specially designed flanges with steeply beveled, polished faces. These grip the diaphragm without the use of gaskets to insure a gas tight fit. Each safety head is guaranteed to burst within 5 per cent of the pressure stamped on an extension tab which is visible outside the flange. Should pressure relief occur the diaphragm bursts wide, leaving a smooth passage for the gases and causing no hazard through flying missiles.

These heads are recommended for use in protection of equipment against the possible failure of safety valves. Their bursting pressure cannot be increased by the operator, or by corrosion, as can a safety valve. A 4-in. diaphragm is said to have the same discharge capacity as 32 2-in safety valves. In installations in which occasional vacuum may occur a special vacuum support is available which does not prevent the proper functioning of the head in case of excess pressure. If desired, heads coated with lead foil for protection against corrosion can be secured in a variety of metals.

Many tests, according to the manufacturers, have shown the practicability of the new safety heads. Ice forming on the head, it is stated, causes little change in the bursting pressure. They are little affected by fatigue under fluctuating pressure. Of the many designs tried, the one shown in the accompanying drawing is the one found to give the most consistent results with the most nearly reproducible accuracy.

Cross section of supporting flanges and safety head



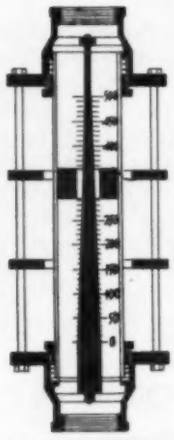
New Gas Analyzer

Continuous, automatic analysis of prepared atmospheres is the function of the new Model RZA analyzer recently developed by the Bacharach Industrial Instrument Co., Pittsburgh, Pa. The instrument is supplied in two forms, one for handling neutral and reducing atmospheres and the other for oxidizing atmospheres. A combination instrument is also available. The first type uses the catalytic property of a heated platinum wire to burn reducing gases and to measure the heat liberated by means of a bridge circuit. The second unit measures the heat conductivity of the gas sample, employing an improved thermal conductivity cell. The unit is said to be both rapid and highly rugged in construction.

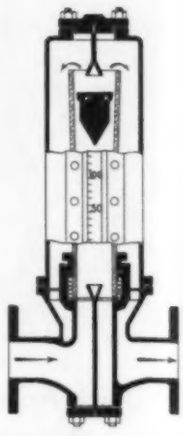
Novel Flow Meters

For indicating the flow rate of oils and other semi-opaque liquids Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa., has developed a new design of Rotameter flow meter in which the customary tapered glass metering tube is replaced by a straight cylindrical tube, the metering element being a tapered pole passing through the rotor, as shown in the drawing reproduced here. The new construction has the advantage, with semi-opaque liquids, that the rotor element is closer to the tube than in standard models and is cylindrical, rather than tapered, and hence can be seen without difficulty. As liquid passes upward through the tube, the rotor is forced upward until it reaches a level corresponding to the flow rate, exactly as in standard types.

Another new Rotameter recently announced is a type in which a rotor of standard shape is guided on a central tube which can be connected to a steam supply. This type is intended for use with viscous solutions which must be heated to lower their viscosity for the measurement of flow rate.



New Rotameter for semi-opaque liquids



New Rotameter for operation at elevated pressures

A third new type of Rotameter, shown as the right-hand sketch of the accompanying drawing, is known as the balanced pressure type and is adapted to the handling of corrosive liquids, vapors and gases at pressures too high for instruments having the metering tube exposed. It is evident that a tapered metering tube of the usual type is employed, but this tube is inclosed within a metal housing. The metering tube and float are visible through two heavy boiler gage glass sight windows capable of resisting a pressure of 1,500 lb. per square inch. The fluid being metered passes upward through the metering tube, then down around the tube, so that the pressure is balanced and no danger of breakage of the tube is incurred.

New Instruments

American Meter Co., Erie, Pa., has recently developed a modification of its "Ironcase" type of meter for use in measuring the flow of oxygen. Construction materials used are especially adapted for the purpose. For high pressure service the meter is equipped with a volume and pressure gage, a base pressure index or a base volume index.

In order to position electrically operated control valves exactly in accordance with process requirements the Automatic Temperature Control Co., 34 East Logan St., Philadelphia, Pa., has brought out two new devices, the Relatrol and the Balancer. The Relatrol duplicates electrically the action of a throttling, air-operated control system, in that the movement of the control valve is proportioned to the deviation of temperature, flow or other controlled variable. However, as in

ordinary air-operated systems, large changes in demand will result in a shift in the control point, so that for such systems the Balancer has been developed, a device which is added to the Relatrol circuit to shift the throttling range and so cause the instrument to control at the same point regardless of demand changes.

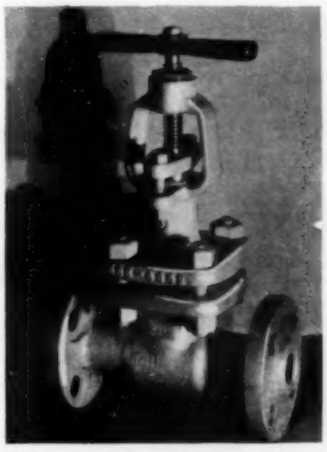
Recent developments of the Bristol Co., Waterbury, Conn., include a fully compensated small-bulb, gas-filled thermometer, a new recorder controller with wide range sensitivity adjustment and a new air-operated, non-recording controller for temperature, pressure and liquid level. The first instrument can be provided with up to 100 ft. of connecting tubing and is offered for temperatures in the range from —60 deg. F. to 1,000 deg. F. The second instrument is of this company's Free-Vane type, an air-operated controller for temperature and other variables, equipped with a sensitivity adjustment that can readily be varied in the field to meet the demands of particular processes. The third, known as Model 90, features the improved measuring element and sensitivity adjustment used in the recording instruments of the company's line, but in a simplified, non-recording construction.

An improved version of the old Protectoglo system of combustion safeguarding, that was manufactured by the Minneapolis-Honeywell Regulator Co., has been introduced by the Brown Instrument Co., Philadelphia, Pa. In this system, it will be recalled, the conductivity of a flame was employed as the actuating medium, the equipment so arranged that loss of flame caused the instrument to operate to shut down the equipment. In the improved form standard radio tubes are used, exceptionally rugged protection is afforded for the relay (which may be located remotely from the electrode unit) and the electrode unit is a new type.

A new development with the Cochrane Corp., North Philadelphia P. O., Philadelphia, Pa., is an improved type of orifice meter for measuring the flow of various sorts of fluids in pipe lines. A mercury-filled manometer is employed and the construction features interchangeable manometer tubes, either a spring or electric clock and a direct-reading integrator. The pressure-tight bearing is of hardened stainless steel and the case adapted for either flush panel or rear mounting. Meter bodies are available for the range from 1 in. w.g. maximum to 200 in.

A remote, hand-operated control for air-operated diaphragm valves is a new development of the Foxboro Co., Foxboro, Mass. The device consists of a manually regulated air valve in conjunction with a gage for showing the control pressure. Through its use it is said to be possible to regulate valves not needing automatic control, from a point as far away as several hundred feet, and with exceptional precision. Another new development of the company is an automatic pressure compensator which is being applied to meters for measuring the flow of compressible fluids. The device consists of a pressure spring which applies a percentage correction to the position of the flow pen, just sufficient to compensate for pressure variations. The compensator is available for both square-root-scale and uniform-scale instruments.

A new construction in industrial thermometers has been announced by the H-B Instrument Co., 2518 North Broad St., Philadelphia, Pa. The case departs from custom in being in one piece. An engraved stem thermometer is used, anchored by an improved means to the insert scale to prevent slipping. The new instrument is compact and available in seven commercial ranges.

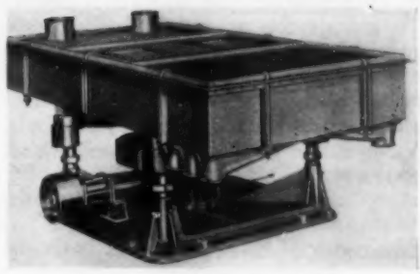


New forged steel globe valve

Forged Steel Valve

Hancock Valve Division, Consolidated Ashcroft Hancock Co., Bridgeport, Conn., has announced a newly improved line of forged steel globe valves for pressure ratings up to 1,500 lb. and high temperature service. The new valves are made either in cone or plug types, employing heat-treated stainless steel for both seat and disk. This trim material is said to be exceptionally hard, resisting wire drawing, indenting and galling.

The new valves are provided with a long condensation chamber to protect the packing while all wearing parts are readily renewable. The valves are designed for easy repacking under pressure.



New circular-motion sifter

Improved Sifter

A new design of sifter for screening in the range from 2 to 250 mesh, which is said to eliminate all dead screen spots, has been announced by Sprout, Waldron & Co., Muncy, Pa., under the name of Roto Sifter. As appears in the accompanying view, the new sifter employs a circular motion which is imparted to every portion of the screen surface. It is claimed by the manufacturer that the new motion lowers screening cost and gives more capacity per square foot of screen surface than has previously been obtainable.

Self-Contained Presses

Farrel-Birmingham Co., Ansonia, Conn., announces two new molding presses of the self-contained, hydraulic-power type, using oil as the fluid. Both presses are designed especially for plastics and rubber molding, one being of 100 tons capacity with 20-in. square platens and the other of 140 tons capacity with platens 60 in. wide and 30 in. deep, of the two platen type. The larger of these two presses is the one shown in the accompanying view. The top crosshead, which also serves as an oil reservoir, is provided with a steel bed plate on the top surface, on which is mounted the variable-displacement

New 140-ton two-platen hydraulic press

pump supplying the hydraulic power. To operate the press but one valve is required, opening or closing of which opens and closes the press. Maximum pressure adjustment of the variable displacement pump is effected by a simple manipulation of the control hand wheel on the pump.

Equipment Briefs

Several new developments have recently been announced by the Patterson Foundry & Machine Co., East Liverpool, Ohio. Among them is the new type UC agitator which has been designed for rigid guiding of the stirrer shaft without the use of a step bearing. As the new agitator is intended for gritty substances it has been provided with a guide bearing protected from the material by a pressure type stuffing box. A three bladed variable pitch propeller is used. New kettles have also been introduced. One is an electrically heated type, built in stainless steel and other materials, equipped with any desired type of agitator or stirrer. Capacities range from 100 to 1,000 gal. in stock sizes. A new type of direct-fired kettle is designed for internal vacuum, is equipped with a removable dished bottom, special cone overflow and inlet valves, a vacuum tight manhole and other features.

Westinghouse has recently extended its line of mercury vapor lamps to include 85 and 250 watt types in addition to the 400 watt model previously announced. With the high efficiency inherent in the new type of lamp, the 85 watt size is said to give light equivalent to a conventional 200 watt incandescent lamp, while the 250 watt is approximately equivalent to 500 watts of incandescent illumination. The average life of the lamps is claimed to be 2,000 hours. Both lamps are produced by the Westinghouse Lamp Co., Bloomfield, N. J.

A new pipe insulation for cold lines announced by Johns-Manville Corp., 22 East 40th St., New York City, is known as Rock Cork pipe covering and is made of a specially waterproofed rock wool provided with a factory applied waterproof jacket. Fittings are insulated with multiple layers of Zerotex, a waterproofed rock wool designed for the purpose.

Hevi Duty Electric Co., Milwaukee, Wis., is now building a muffle furnace for temperatures as high as 2,350 deg. F., equipped with Smith Alloy 10 electric resistance elements. A temperature 50 deg. higher is safe for short periods. In addition to laboratory drying, ignitions and fusions, the new furnace is recommended for enamel smelting, enameling and ceramic firing.

Vacuum deaeration of numerous sorts of liquids is possible with a new vacuum deaerator recently announced by the Croll-Reynolds Engineering Co., 17 John St., New York City. The deaerator consists of a vessel evacuated by a one or two stage steam jet pump, or a mechanical pump if desired. Within the vessel are alternate convex and concave baffles so arranged as to give the maximum exposure of liquid flowing over them. Considerable space at the top is provided for settling the foam that is frequently produced when liquids of some types are first subjected to the vacuum.

Objects resembling soft vulcanized rubber, which are resilient and elastic and can be molded in three minutes, can be produced from a new molding powder announced by the Thiokol Corp., Yardville, N. J. The material is said to be flexible at temperatures as low as —45 deg. F., to withstand hot oil up to 200 to 225 deg. F., and to have excellent age-resisting properties. Molding costs are said to be much lower than those in ordinary rubber molding.

MANUFACTURERS' LATEST PUBLICATIONS

Alloys. Globe Stainless Tube Co., 4010 West Burnham St., Milwaukee, Wis.—Bulletin 1-E—six-page folder giving complete tabulation of analyses of stainless steels made by various manufacturers.

Ammonia. The Barrett Co., 40 Rector St., New York City—"Ammonia in Petroleum Refining, Second Edition," 19-page revision of this company's earlier booklet on the uses of ammonia in petroleum refining for corrosion prevention, neutralization and refrigeration, with information on cost, flow and chemical control.

Apparatus. Bausch & Lomb Optical Co., Rochester, N. Y.—Catalog D-202—12 pages on Abbe dipping type refractometers.

Apparatus. Hellige, Inc., 3702 Northern Boulevard, Long Island City, N. Y.—Bulletin 7030—Four pages describing this company's new vacuum-tube galvanometer.

Boilers. Commonwealth Electric & Mfg. Co., 83 Boston St., Boston, Mass.—Bulletin 52B—New eight-page catalog covering this company's electrically heated steam generators and accessories, capacity 2 to 24 kw.

Centrifugals. Sharples Specialty Co., 23d and Westmoreland Sts., Philadelphia, Pa.—Reprint of three-page article describing use of Super-Centrifuges in the solution of a number of processing problems.

Chemicals. Dewey & Almy Chemical Co., Cambridge B, Mass.—Form 89D-1—eight pages on this company's Daxad line of dispersing agents with actual photographic prints (not halftones) of results obtained.

Chemicals. Hercules Powder Co., Wilmington, Del.—12 pages on chemical and physical properties and uses of ethyl cellulose.

Colloid Mill. Manton-Gaulin Mfg. Co., Everett, Mass.—Eight page bulletin describing a new colloid mill providing double treatment and especially efficient cooling for fine or coarse materials, heavy or light liquids.

Cooling Towers. Fluor Corp., Ltd., 909 East 59th St., Los Angeles, Cal.—Bulletin T 236—12 pages with engineering data on this company's Aerator cooling towers.

Conveyors. Syntron Co., 400 North Lexington Ave., Pittsburgh, Pa.—Form 210—Eight pages on electrically vibrated feeder conveyors made by this company.

Equipment. Oliver United Filters, Inc., 33 West 42d St., New York City—Publications as follows: Bulletin 111, four pages on Sweetland pressure filters; Bulletin 302, four pages on Olivite acid-resisting pumps; Bulletin 405, seven pages on this company's equipment for use in oil refineries.

Equipment. Sutorbilt Corp., 2008 East Slauson Ave., Los Angeles, Cal.—Loose leaf catalog of bulletins covering equipment made by this company, including positive rotary blowers, liquid pumps, V-belt drives, industrial fans and pneumatic conveyors.

Equipment. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: Bulletin L-611-B11, Horizontal two-stage compressors; L-611-B12, Horizontal three-stage compressors; L-620-B16, Two-stage vertical compressors; S-500-B22, Vertical four-cycle diesel engines; W-321-B9, Close-coupled motorized centrifugal pumps.

Fans. Northern Blower Co., West 65th St., Cleveland, Ohio—Bulletin 1002-2—four pages on this company's slow-speed exhaust fans for dust collecting equipment.

Fire Control. Garrison Engineering Corp., Great Barrington, Mass.—36 pages on this company's equipment for fire fighting through the use of the Garrison dry method.

Instruments. Brown Instrument Co., Philadelphia, Pa.—Six-page folder briefly describing features of this company's new line of air-operated controllers.

Instruments. Leeds & Northrup Co., 4900 Stenton Ave., Philadelphia, Pa.—Catalog N-33A—52 pages completely describing this company's line of thermocouple pyrometers and accessories.

Instruments. C. J. Tagliabue Mfg. Co., Park & Nostrand Aves, Brooklyn, N. Y.—Catalog 1101B—16 pages and price list covering the line of photo-electrically balanced pyrometers made by this company.

Lighting. Holophane Co., 342 Madison Ave., New York City—44-page catalog entitled "Datalog," describing this company's latest equipment for lighting.

Materials Handling. Lewis-Shepard Co., Watertown, Mass.—Circular 320—Folder briefly describing a number of unusual mechanical lifters.

Materials Handling. Yale & Towne Mfg. Co., Philadelphia Division, 4530 Tacony St., Philadelphia, Pa.—20-page booklet describing this company's complete line of overhead materials handling equipment.

Melting Pots. Harold E. Trent Co., 618 North 54th St., Philadelphia, Pa.—Leaflet TD-11—Four pages describing this company's electric melting pots.

Paint. Patterson Foundry & Machine Co., East Liverpool, Ohio—12-page reprint of an address on recent trends in the paint and varnish industry, with particular reference to the use of this company's equipment.

Power Transmission. Falk Corp., Milwaukee, Wis.—Bulletins 1100 and 2100—Respectively 56 and 60 pages on herringbone, and horizontal and vertical right-angle speed reducers, both with extensive application data.

Power Transmission. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill.—Catalog 1557—24 pages tabulating stock sprocket wheels for this company's Silverlink roller chains; also Catalog 1552, 16 pages on Silverlink conveyor chains.

Proportioning. Blaw-Knox Co., Pittsburgh, Pa.—Bulletin 1529—Eight pages illustrating and describing a variety of batching equipment made by this company.

Proportioning. D. W. Haering & Co., 3408 West Monroe St., Chicago, Ill.—12-page booklet describing principles and construction of this company's equipment for liquid proportioning.

Pumps. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Leaflet 2224—Four pages on single-suction centrifugal pumps, direct connected and belted.

Pumps. Goulds Pumps, Inc., Seneca Falls, N. Y.—Form 3311-J—Four pages describing Fig. 3605 centrifugal pumps for chemical processes.

Regulators. Sarco Co., 183 Madison Ave., New York City—Bulletin 140—Leaflet describing a new temperature control blender for mixing hot and cold water or other fluids.

Scales. Exact Weight Scale Co., Columbus, Ohio—32-page book, "Industry at Work," showing pictorially application of this company's scales in industry.

Solders. Handy & Harman, 82 Fulton St., New York City—Bulletin 1—Gives detailed instructions on the use of this company's silver solders, Sil-Fos and brazing alloys.

Valves. American Car & Foundry Co., 30 Church St., New York City—Catalog 2—64 pages on a full line of lubricated plug valves made by this company.

Viscosimeters. Fish-Schurman Corp., 230 East 45th St., New York City—Five-page direction sheet on principles and operation of Hoeppler falling-ball viscosimeters.

Water Treatment. Permutit Co., 330 West 42d St., New York City—Eight-page booklet briefly describing this company's system of internal boiler feedwater treatment.

Welding. Lincoln Electric Co., Cleveland, Ohio—Chart for drafting room use concisely presenting data necessary for producing arc-welded designs.

Chemical Engineering NEWS

Clay Products Producers Discuss Plant Problems

THE Clay Product Plant Operators' Conference was held at the University of Illinois, Urbana, on June 12-13 under the auspices of the Department of Ceramic Engineering. The attendance of 60 represented clay products producers in 14 states.

M. L. Enger, Dean of the College of Engineering, opened the conference with a brief address of welcome. Hugo Fillippi, Illinois Brick Co., Chicago, presented a paper on "The Steam Power Plant Problem in the Clay Plant." The importance of the power plant was indicated by the fact that the cost of power in the clay plant represents from 15 to 50 per cent of the total direct cost of manufacturing.

Other papers presented included: "Diesel Power in the Clay Plant," by Fred H. Schwetye, Walsh Refractories Corp., Vandalia, Mo.; "Electrical Efficiency and Economics in Plant Operation," by J. O. Kraehenbuehl, assistant professor, Department of Electrical Engineering, University of Illinois; "De-airing," by Wayne E. Barrett, Purington Paving Brick Co., Galesburg, Ill.; "Pugging," by H. R. Straight, Adel Clay Products Co., Adel, Iowa; "Basic Principles of the Drying Operation," by R. K. Hursh, Department of Ceramic Engineering, University of Illinois; "Operation and Control of Dryers," by Amos P. Potts, Clay Product Co., Brazil, Ind.; "The Effect of Heat on Clays," by Prof. T. N. McVay, University of Alabama; and "Methods of Firing Control," by V. W. Boeker, Richards Brick Co., Edwardsville, Ill.

New Research Associate Plan at Battelle

THE Trustees of Battelle Memorial Institute have announced a new plan to extend the scope and utility of the educational features of the Institute's basic program of scientific research. Since its inception, the policy of Battelle Memorial Institute has been to combine a program of fundamental research of general interest to industry with the applied research which it has carried on for individual companies and associations under its plan of sponsored research.

A new Division of Research Associates has been established to supplement the work in fundamental science of the regular technical staff. The purpose of this new division is to offer intensive training in practical research to the best of the younger workers in selected branches of chemistry, metallurgy, fuels and ceramics. Appointments as Research Associate will be made for one year's duration and may be extended for a second year. A Research Associate will be expected to devote his entire time to a research problem approved by the director and supervised by members of the Institute staff. The results of these researches will be published in order to contribute information that will be useful to science and industry.

Appointments as Research Associate are open to graduates of any accredited university or college, but preference will be shown to men who have demonstrated a marked aptitude for scientific research in their industrial experience or through one or more year's graduate study. The appointment will carry an annual salary of from $1,200 to $1,800 depending on the training and experience of the individual. Four appointments as Battelle Research Associate will be made for the year 1936-1937.

Sixtieth Anniversary Will Be Celebrated by A.C.S.

CELEBRATING the sixtieth anniversary of its founding, the American Chemical Society will hold a five-day national meeting in Pittsburgh beginning Sept. 7. Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, Pittsburgh, and president-elect of the Society, has been named honorary chairman of the event, which will be attended by chemists, industrialists, educators, government researchers, and scientists representing allied fields.

Chester G. Fisher, president of the Fisher Scientific Co., heads a Pittsburgh committee of 105 which will shape a local program with the cooperation of the industries, the U. S. Bureau of Mines, and the educational institutions of the Pittsburgh district.

Nineteen scientific divisions of the Society will hear reports of world progress in practically every field of chemical science. Four sessions will be devoted to coal. Chemists from England, Germany, and the United States will speak on the hydrogenation of coal under the auspices of the Division of Gas and Fuel Chemistry.

Research to be reported at other sessions include the fields of agriculture and food, biological, cellulose, colloid, fertilizer, industrial and engineering, medicinal, organic, paint and varnish, petroleum, physical and inorganic, rubber, sugar, and water, sewage and sanitation chemistry; the history of chemistry, chemical education, and microchemistry.

At a general session on Sept. 9 the Society will formally present the Langmuir Prize of $1,000 to Dr. John Gamble Kirkwood of Cornell University for "the most outstanding original research by a chemist under thirty-one years of age." Dr. Kirkwood will describe his investigation in a paper to be read before the Division of Physical and Inorganic Chemistry.

Foreign Countries Increase Chrome Ore Production

REPORTS to the Department of Commerce state that foreign engineers recently arrived in New Caledonia are showing interest in chrome mines. Prospectors have discovered large deposits near Sarramea with a chrome content of 49 per cent. Deposits at Toumourou and the Plateau in the valley of the Ouenghi also will be exploited and work at the Koniambo mine is being speeded up.

Production of chrome ore in Turkey also is increasing with estimates of 150,000 metric tons for 1935 compared with 120,000 tons for 1934 and 80,000 tons for 1933.

In 1935, United States imports of chrome ore was 259,063 tons with a chromic acid content of 116,277 tons valued at $3,604,491. Principal points of shipment in their order of importance were Mozambique, French Oceania, Cuba, Greece, Union of South Africa, Turkey, British India, and other British South Africa.

American Welding Society Will Meet in Cleveland

TENTATIVE program for the Seventeenth Annual Meeting of the American Welding Society has been announced. Technical sessions and committee meetings will be held at the Hotel Cleveland, Cleveland, Oct. 19-23 and the Metal Congress Exposition will be presented in the Cleveland Public Auditorium, Oct. 19-24.

On Monday morning Oct. 19, a business session will be held at which President J. J. Crowe will deliver his report on society activities, the respective chairmen of committees will review their work, and the teller will report the result of balloting for officers. The award of the Samuel Wylie Miller Memorial Medal also will be made.

Technical sessions will take up the greater part of the other meetings with joint sessions on Thursday morning and afternoon with the American Society of Mechanical Engineers.

Large Gain in Consumption Of Potash Salts

DOMESTIC potash production last year amounted to 357,974 short tons, figures just issued by the United States Bureau of Mines show, which is equivalent to 192,793 short tons of actual potash (K_2O). Compared with the previous year this represents an increase of 30 per cent in gross weight and 34 per cent in K_2O content.

Imports of potash salts during 1935 totaled 603,595 short tons, equivalent to 241,510 short tons of potash, an increase of 24 per cent in gross weight over the imports of 1934, which were 486,167 tons. Ninety-four per cent of the imports was used in fertilizers, while the potassium salts imported for the chemical industry amounted to 34,176 short tons, a decrease of 11 per cent in value. Foreign potash for fertilizer use on the other hand showed a gain in value of 15 per cent over 1934.

Sales of salts in the domestic market last year amounted to 406,922 tons, an increase of 81 per cent over the previous year, and 14 per cent more than production. The value of potash salts sold, at the plant, was $4,990,481, an increase of 78 per cent. The average value per ton was $12.27 in 1935, compared with $12.51 in 1934. The value per unit (20 pounds) of K_2O was 22 cents in 1935.

Consumption of potash materials in 1935, as represented by sales plus imports less exports amounted to 930,893 tons valued at $14,876,657, with an estimated K_2O content of 420,000 tons, of which about 43 per cent was of domestic origin. This represented an increase in consumption over 1934 of 37 per cent in gross weight, 57 per cent in K_2O content, and 14 per cent in value.

The chief sources of potash production in 1935 were from natural brines at Trona, Calif., where the potash is produced as a co-product with borax and other sodium compounds and from potash minerals mined at Carlsbad, New Mexico.

Potash was also recovered from distillery waste and from cement kiln dust. Small quantities of cotton boll ashes and of alunite or other potash-bearing rocks were shipped for experimental work, fertilizer filler or for direct application as a fertilizing agent.

Principal producers were American Potash & Chemical Corp., New York, and Trona, Calif.; United States Potash Co., Inc., New York, and Carlsbad, N. Mex.; the Potash Co. of America, Denver, and Carlsbad, N. Mex.; United States Industrial Chemical Co., Inc., New York, and Baltimore; and North American Cement Corp., Albany, and Security, Md.

Du Pont Announces New Urea-Ammonia Liquor

THE Ammonia Department, E. I. du Pont de Nemours & Co. announces the production of an improved ammoniating liquor known as Urea-Ammonia Liquor-B (UAL-B). The expansion of facilities for urea production at du Pont's Belle, (W. Va.) plant has made possible the production of the improved urea-ammonia liquor.

UAL-B differs from UAL-A, the product that has been on the market for four years, principally in having a higher content of urea and a proportionately lower content of free ammonia. The higher proportion of fixed (urea) nitrogen in UAL-B enables a manufacturer to add 60 per cent more urea nitrogen or 20 per cent more total nitrogen to a fertilizer than could be secured from UAL-A. Many manufacturers have derived 40 pounds of nitrogen from UAL-A in making a complete fertilizer. With the new liquor they can derive 48 pounds of nitrogen from the solution. In the first case, the fertilizer would contain 13.2 pounds of nitrogen from urea and in the second case 20.1 pounds of nitrogen would be in the form of urea.

In the manufacture of bases from superphosphate and urea-ammonia liquor, many manufacturers have used 145 pounds of UAL-A per ton, deriving 3.29 units of nitrogen without experiencing significant reversion of phosphoric acid. With UAL-B the amount can be increased to 177 pounds per ton, to make a base containing 4.0 units of nitrogen.

Hercules to Manufacture Cellulose Acetate

NEGOTIATIONS have just been completed between Hercules Powder Co., of Wilmington, Delaware, and the I. G. Farbenindustrie Aktiengesellschaft, of Frankfurt, Germany, by which Hercules comes into control of the American patents covering the I. G. processes on manufacturing cellulose acetate.

M. G. Milliken, general manager of the Cellulose Products Department, stated that Hercules expects to be in quantity production of flake cellulose acetate by December. The experimental and pilot units at the company's extensive cellulose products plant at Parlin, N. J., have been running successfully for several years and a material of high quality with improved properties is being produced. Work on the new large scale plant is progressing.

Use of Leaded Gasoline Gained 12 Per Cent

USE of leaded gasoline in 1935 showed a gain of 12 per cent over 1934, according to figures made public by J. C. Taylor, sales manager of the Ethyl Gasoline Corp. The rate of increase was double that of all gasoline sold in the United States, with the biggest advances reported from the seven states comprising the corporation's Los Angeles division, where consumption jumped 32.8 per cent.

Total gasoline sales for 1935 are estimated at 17,000,000,000 gallons, a 6 per cent increase. Of this amount, 12,000,000,000 gallons were leaded. Approximately 72 per cent of all gasoline now being marketed contains lead. In 1933, the leaded total was 4,297,000,000 gallons; in 1934 it was 10,698,000,000 gallons. In slightly over two years, from June, 1933 to October, 1935, the consumption of leaded gasoline rose from 19.64 per cent to 68.9 per cent.

Glass Problems Conference Held at Illinois

MORE than 70 ceramists, ceramic engineers and others interested in glass production attended the fourth conference on glass problems held at Urbana on June 5 and 6 under the auspices of the Department of Ceramic Engineering of the University of Illinois, and the American Ceramic Society. Several of the ten papers covered such subjects as temperature measurement and control in glass manufacture, heat transfer in glass tanks, batch separation and other operating matters.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

WITH THE signing of the Walsh-Healey government contracts bill, late in June, President Roosevelt set in motion a law which observers in Washington are insisting is headed directly for early action by the Federal—possibly the Supreme—courts.

This bill's enforcement is now in the hands of Secretary Perkins of the Department of Labor, who, within ninety days must formulate regulations for its administration. Those regulations among other things will provide for an eight-hour day and a forty-hour week, and for the paying of workers at a minimum rate to be set by Madam Secretary Perkins. They also will forbid the working of boys under 16 and girls under 18 years of age, and will set definite standards for working conditions complying with the terms of the law which prohibits work on government contracts under conditions which are unsanitary or dangerous to health or safety.

Under section nine of the measure that this "act shall not apply to the purchase of such materials, supplies, articles or equipment as may usually be bought in the open market" nor shall it apply to "farm products processed for first sale."

The act appears certain to make trouble for government purchasing agents as well as for firms wishing to do business with the government, and there are not lacking those who assert that in reality it merely recreates a new NRA, with government supervision of manufacturing operation with plant inspections.

The chief objections so far raised against the measure is that it is an indirect attempt to regulate hours and wages, matters over which the New Deal has stumbled in the courts before.

In close co-operation with the Paint, Varnish and Lacquer Association headquarters in Washington, the Bureau of Foreign and Domestic Commerce has started the publication of a monthly bulletin digesting trade hints.

The bulletin will carry current figures on paint product sales as well as other figures of interest to the industry, with notes on trends in decorations, furnishing, construction and like subjects. Among the topics planned for discussion will be advanced news on seasonal prospects for sales, improving stock control to increase profits and how to sell service rather than just paint.

The bulletin fits in with the campaign just gathering momentum and launched by the paint industry to sell paint and painting on an installment plan basis, whereby the dealer or contract painter will receive his pay immediately and the owner will pay for the job out of income. This plan is one of the outgrowths of the National Housing Act, which permits financing companies to insure loans for painting jobs.

Study of the chemical substances of food and other agricultural products as well as of textiles, which contribute to allergic disturbances such as hay fever, hives, asthma, and the like, is under way now in the Division of Chemistry and Soils, Department of Agriculture.

In announcing the commencement of the study Dr. W. W. Skinner, assistant chief of the division, lays stress on the point that the work is designed to assist the medical profession, and is being aided by medical specialists who are devoting time to the work.

Many people suffer from seasonal or continual disturbances and lessened vitality as a result of these allergic troubles, due to abnormal sensitiveness to certain normal constituents of pollens of many of the grasses, trees or weeds. Similar substances are found in certain foods, textile fabrics, furs, and other products and the Department experts are seeking the foundational causes. The substances are usually absorbed through the skin, the respiratory or digestive membranes. Dr. Henry Stevens, biochemist of the Protein and Nutritive Division is in charge of the investigation.

Uncle Sam's Department of Agriculture, Food and Drug Administration, has clapped down on artificially colored orange drinks, and from 16 different key cities through the country, is watching the bottlers with an eagle eye.

Formal notice was sent to the trade last November that July 1 would be the dead line after which the Administration agents would insist upon the observance of the strict letter as well as the spirit of the law. In January a supplementary notice was sent to the whole orange beverage industry, announcing the Department would not initiate action against artificially colored stocks of orange beverage bases, prepared before Nov. 15, 1935, as the trade had laid in sufficient stocks of the artificially colored beverage bases to last until the coming Valencia orange season.

Hearing on the proposed new rules for tankers and dangerous cargoes, held under the chairmanship of Joseph B. Weaver, chief of the Bureau of Marine Inspection and Navigation, Commerce Department, in Washington recently, brought three points clearly to the fore.

The first of these is the need for immediate action on a code which will increase the safety of lives and property afloat. The second was the danger that overlapping jurisdiction of the Bureau and the Interstate Commerce Commission, might confuse shippers and add to their difficulties, and should be eliminated in the proposed code. The third was that the rules, as suggested by the Bureau, would, in all probability, be approved as they stand, with certain minor modifications or amendments.

Much time and talk was devoted to the second point, several speakers appearing to fear the results of the dual jurisdiction permitted under the rules. Mr. Weaver, however, in a brief statement, attempted to allay this apprehension, by saying that the relations of his bureau and the ICC were most cordial.

However, the feeling after the hearing was that alterations probably would be made in the rulings to meet this objection.

In this connection a report circulating in Washington to the effect that the ICC and the Commerce department are now seeking to develop a working agreement is of special interest.

At the beginning of the month the District of Columbia Court of Appeals upheld a lower court ruling which dismissed a suit by Haskins Bros. & Co. of Iowa, to compel the Treasury to return taxes paid on Philippine coconut oil.

The ruling confirmed the District of Columbia Supreme Court decision which threw out the company's suit against Treasury officials and the Comptroller of the United States to recover $160,879 collected between May 10, 1934, and December 31, 1935, under provisions of the Revenue Act of 1934.

The Iowa corporation, a manufacturer of soap, contended that the tax was unconstitutional, and that the levy was collected under coercion of threats of penalties, interests and liens.

The act imposes a tax of three cents a pound on the first domestic processing of certain vegetable oils, including coconut oil, and an additional tax of two cents on the first domestic processing of coconut oil not produced in the Philippines.

The company alleged that between May 10, 1934 and December 31, 1935, the United States collected from manufacturers "similarly situated" more than $26,000,000 "which fund is now held in the Treasury of the United States as a separate fund and is earmarked as such for the benefit of, and to be paid over to, the Philippine Islands, under and by virtue of said act."

Larger Sales of Natural Sodium Compounds

PRODUCTION of sodium compounds, not including common salt, from natural salines and brines in the United States in 1935, as indicated by sales or shipments by producers, amounted to 404,903 short tons valued at $6,930,506. These figures which include the output of sodium carbonate (soda ash and trona), sodium bicarbonate, sodium sulphate (salt cake and glauber's salt), and sodium borate (borax and kernite), show an increase of 17 per cent in quantity and 11 per cent in value compared with the output in 1934 (347,475 short tons valued at $6,224,352).

The sodium carbonates reported in 1935 were from California and amounted to 93,230 short tons valued at $1,173,003, compared with 88,325 tons valued at $1,254,113 in 1934, an increase of 6 per cent in quantity but a decrease of 6 per cent in value. They were produced in California from Owens Lake, by the Pacific Alkali Co., Bartlett, and Natural Soda Products Co., Keeler, and from Searles Lake, by the American Potash & Chemical Co., Trona, and the West End Chemical Co., Westend.

Sodium sulphate (salt cake and glauber's salt) shipments amounted to 38,706 tons valued at $375,943 in 1935 compared with 16,650 tons valued at $148,225 in 1934, an increase of 132 per cent in quantity and 154 per cent in value. Production of salt cake was reported for the second year by the American Potash & Chemical Co., Trona, Calif., and largely accounts for the increased output of this salt in 1935; The Ozark Chemical Co., (Tulsa, Oklahoma) produced a considerable quantity near Monahans, Texas; the deposit of Rhodes Alkali & Chemical Corp., near Mina, Nevada, was not operated but sales were made from stock; and a small amount for medicinal purposes was produced by the Spokanogan Chemical Co., at Okanogan, Washington. Hydrated sodium sulphate (glauber's salt) was produced near Casper, Wyoming, by W. E. Pratt. The Iowa Soda Products Co. mined glauber's salt near Rawlins, Wyoming.

Total imports of sodium sulphate in 1935 amounted to 116,718 short tons valued at $1,077,691, an increase of 18 per cent in quantity and 13 per cent in value over 1934. Imports of anhydrous sodium sulphate amounted to 5,788 short tons valued at $113,771 in 1935, compared with 8,409 short tons valued at $151,490 in 1934; imports of glauber's salt amounted to 551 short tons valued at $4,479 in 1935 against 533 short tons valued at $4,116 in 1934, and imports of crude sodium sulphate amounted to 110,379 short tons valued at $959,441, compared with 89,701 tons valued at $799,141 in 1934. Exports of sodium sulphate are not separately recorded.

The total boron minerals shipped by producers amounted to 272,967 short tons, valued at $5,381,560 compared with 242,500 short tons valued at $4,822,014 in 1934, an increase of 13 per cent in quantity and 12 per cent in value over 1934.

Dechema Holds Tenth Meeting at Munich

THE tenth general meeting of the Dechema Deutsche Gesellschaft für Chemisches Apparatewesen E.V. was held in conjunction with the National Congress of German Chemists at Munich, July 9-10. Among the speakers were Prof. Dr. P. Duden, Frankfort-on-the-Main, spoke on "Ten Years of the Dechema." Prof. Dr. H. H. Franck, Berlin, discussed "Standardizing as a Principle of Technical Thought." Prof. Dr. Ing. O. Fuchs, Darmstadt, chose for his subject "The Extraction of Liquids and Vapors by Means of Liquids," and Dr. Ing. habil Fr. Prockat, Berlin, discussed "Physical Basis, Problems and Present State of Development of the Theory and Science of Filtration."

Papers also were read regarding the results of The First International Congress of Chemical Engineering recently held in London. Numerous papers also were read on the use of electrically produced heat in chemical engineering.

Dr. Price Speaks on Control Of Dust Explosions

LEAVING Washington early this month Dr. D. J. Price, who is in charge of the research work on dust explosion and fire prevention in the Chemical Engineering Division of the Bureau of Chemistry and Soils, is on a speaking tour during which he will discuss methods for preventing dust explosions.

Firemen in attendance at the Texas State Firemen's School at College Station on July 15 will hear Doctor Price discuss fire fighting methods. At the Pacific Coast Fire Chiefs' Conference in Seattle July 21-23 he will discuss the dust explosions which have occurred in the Western States during the past year. Special meetings with firemen, farm associations, industrial and safety organizations, fire prevention engineers, and other interested agencies will be held in Dallas, Texas, July 13, Denver, Col., July 17; Spokane, Wash., July 20; Portland, Ore., July 24-25; San Francisco, Calif., July 27-28; Los Angeles, and San Diego, Calif., July 29-31; and Salt Lake City, Aug. 1-2. At Waukesha, Wis., Aug. 5, Doctor Price will discuss recent developments in farm and rural community fire prevention at the annual convention of the Wisconsin Paid Firemen's Association. In Chicago on Aug. 6, he will address a special meeting of the Chicago Safety Council on recent developments in dust explosion prevention in industrial plants.

Exhibit of E. I. duPont de Nemours & Co. at the Texas Centennial Exposition. The exhibit is in an enclosed space equipped at one end with a motion picture theatre seating 100 persons

First 1935 Census Report Covers Rayon Yarn

BOTH production and employment in the manufacture of rayon yarn and allied products in 1935 showed marked increases over preceding years, it was revealed by Director William L. Austin of the Bureau of the Census in the first report of the 1935 Biennial Census of Manufactures, now under way.

Rayon-yarn production in 1935 amounted to 265,142,656 pounds, an increase of 24.2 per cent over the total for 1933 (the last preceding census year), which in turn was well in excess of the production reported for any earlier year. A substantial increase in wage-earner employment is also recorded, the 1935 figure, 50,165, being 13.2 per cent above the corresponding one for 1933. The total value of all products made in 1935 by manufacturers of rayon and allied products was $181,154,983, an increase of 15.4 per cent as compared with 1933, and of 36.6 per cent over 1931.

This industry, as defined for census purposes, embraces establishments engaged wholly or principally in the manufacture of rayon yarn and of products of similar composition in the form of sheets, straw, horsehair, etc. It does not cover establishments engaged primarily in the manufacture of products from rayon as a material.

Tubize Chatillon Will Expand Rayon Plant

PLANS have been announced by the Tubize Chatillon Corp. for the erection of a new viscose yarn unit at its plant in Rome, Ga. The proposed new addition will increase the corporation's yarn capacity by about 5,000,000 lb. annually. The plans call for bank loans of $2,800,000. A special meeting of holders of preferred stock and Class A stock has been called for 10:30 A. M., July 30, at the headquarters of the company in 2 Park Avenue, New York, for the purpose of approving the loans.

Brazil Increases Use of Alcohol as Motor Fuel

SUPPORTED by national legislation the use of alcohol as a motor fuel in Brazil has gained steadily in recent years, according to reports from Assistant Trade Commissioner A. A. Barrington, Rio de Janeiro.

The output of motor alcohol exceeded 12½ million gallons in 1935 compared with 7 million gallons in 1934. With distilleries now in operation together with those under construction and projected, it is anticipated that approximately 26½ million gallons will be available for motor fuel during the current year.

Federal legislation now in force requires that all gasoline sold for use in motor vehicles in Brazil shall contain 10 per cent alcohol. Production has not been sufficient to enable the government to enforce the ruling in all parts of the country. During the greater part of 1935 and during the current year the requirement has been observed in the State of Rio de Janeiro.

The Brazilian Government reserves the right to increase the percentage of alcohol to be mixed with gasoline, and it is believed that the ratio will be consistently advanced as the national output expands.

Brazil with its important sugar industry has large quantities of byproduct molasses suitable for the manufacture of alcohol as well as many other vegetable products, including mandioca, available for the purpose. The present output comes largely from molasses with one plant established by the Minas State Government in 1932 using mandioca exclusively as a raw material.

Brazil imports approximately 100 million gallons of gasoline annually for use in its 130,000 automobiles.

Nitrogen Plant Converted To Make Hydrogen

ACCORDING to a report from Consul Sydney B. Redecker, Frankfort-on-Main, Germany, the Scholven nitrogen plant of the State-controlled Hibernia Coal and Iron Co. was recently converted for the production of hydrogen to be used in manufacture of synthetic motor fuels. The Scholven plant had a yearly capacity of 20,000 metric tons fixed nitrogen. In view of the closing of the Scholven plant, the Hibernia concern doubled capacity of its other nitrogen plant at Holsterhausen, effective January 1, 1936, and the latter will now produce at the rate of 27,000 tons annually. One-half the output will be absorbed by the I. G. Farbenindustrie in the form of ammonia for further processing. The other half will be marketed as calcium-ammonium nitrate, ammonium sulphate nitrate, sodium nitrate and nitric acid.

Production and Sales of Coal-Tar Crudes, 1935

THE Tariff Commission has released statistics which it has compiled on the production and sales of coal-tar crudes in 1935 by purchasers of tar. These data, combined with statistics compiled by the Bureau of Mines from reports of producers of tar, are summarized in the table, which also shows, for comparative purposes, statistics for 1934.

Substantial increases in output over 1934 occurred in nearly all the crudes except road tars which decreased 15 per cent. Especially notable was the larger production compared with 1934, of toluol (about 30 per cent increase), naphthalene (25 per cent), creosote oil (29 per cent), and other distillates (52 per cent).

Production and Sales of Crude Coal-Tar Products [1], 1934 and 1935

		1934	1935
		gal.	gal.
Tar distilled: [2]			
Oil-gas tar		1,167,127	1,911,650
Water-gas tar		30,992,011	30,115,339
Coal tar		231,826,608	244,516,809
Total		263,985,746	276,543,798
Tar [2]			
Production	gal.	408,710,314	450,307,827
Sales	gal.	273,763,739	308,705,919
Sales value		$10,760,125	$12,597,705
Light oil and derivatives:			
Crude light oil			
Production	gal.	119,287,276	134,070,840
Sales	gal.	12,073,697	12,327,539
Sales value		$1,026,052	$1,052,831
Benzol (except motor benzol)			
Production	gal.	23,820,502	24,106,006
Sales	gal.	19,875,080	23,029,543
Sales value		$3,215,164	$2,975,658
Motor benzol [3]			
Production	gal.	50,046,610	58,379,910
Sales	gal.	49,224,891	57,542,312
Sales value		$4,615,604	$5,120,881
Toluol, crude and refined			
Production	gal.	[3] 13,281,794	17,776,551
Sales	gal.	[3] 13,240,880	17,648,286
Sales value		[3] $3,638,031	$4,929,219
Solvent naphtha			
Production	gal.	3,878,554	4,970,842
Sales	gal.	3,592,029	4,742,388
Sales value		$688,557	$985,124
Xylol [3]			
Production	gal.	2,736,295	3,695,656
Sales	gal.	2,752,302	3,747,959
Sales value		$633,341	$860,891
Other light oil products			
Production	gal.	[4] 4,524,016	[5] 6,812,455
Sales	gal.	[4] 2,109,629	[5] 4,005,458
Sales value		[4] $339,290	[5] $403,785
Naphthalene, crude and refined [6]			
Production	lb.	37,922,455	47,653,372
Sales	lb.	31,930,189	42,017,954
Sales value		$516,938	$698,088
Crude tar acids			
Production	gal.	16,754,462	[7]
Sales	gal.	1,263,404	[7]
Sales value		$304,300	[7]
Creosote oil			
Production	gal.	71,999,286	92,869,152
Sales	gal.	90,539,256	86,706,628
Sales value		$8,297,019	$8,819,335
Tars, crude and refined [2]			
Production	gal.	13,414,731	16,575,539
Sales	gal.	11,021,318	15,179,905
Sales value		$880,618	$1,208,093
Tars, road [2]			
Production	gal.	132,307,554	112,038,763
Sales	gal.	137,482,713	110,612,482
Sales value		$10,608,770	$9,253,333
Other distillates [2]			
Production	gal.	9,875,828	15,251,053
Sales	gal.	8,634,508	7,462,852
Sales value		$1,267,500	$1,051,857
Pitch of tar			
Production	tons	407,327	436,570
Sales	tons	317,943	285,542
Sales value		$3,791,234	$3,533,576
Pitch of tar coke [2]			
Production	tons	45,128	80,020
Sales	tons	53,056	74,970
Sales value		$502,368	$821,291

[1] Data for coke ovens reporting to Bureau of Mines, and for tar refineries and others reporting to U. S. Tariff Commission, unless otherwise noted.
[2] Reported to U. S. Tariff Commission only.
[3] Reported to Bureau of Mines only.
[4] Includes toluol and xylol reported to U. S. Tariff Commission.
[5] Includes xylol and motor benzol reported to U. S. Tariff Commission.
[6] Includes crude and refined naphthalene reported to Bureau of Mines and crude naphthalene reported to U. S. Tariff Commission.
[7] Not publishable.

PERSONALITIES

COLIN G. FINK, head of the electrochemical department at Columbia University, has had the honorary degree of doctor of science conferred upon him by Oberlin College. At the conference of the International Chemical Union to be held in Switzerland in August, Dr. Fink will be the American guest speaker.

R. E. PAXSON, who for the past three years has been located at the Delta, Colo., plant of the Holly Sugar Corp. in capacity of assistant chemist, was transferred on July 1 to the Torrington, Wyo., plant of the same company. He will serve as special assistant chemist. Mr. Paxson received his chemical engineering degree at Colorado University in 1932.

JOSEPH and ROBERT SHARBAUGH, twin brothers, graduated from the chemical engineering department at the University of Pittsburgh in June. Joseph will be employed by the American Rolling Mills at Butler, Pa., while Robert will be associated with the Westvaco Chlorine Products, Inc. at Charleston, W. Va.

CLARENCE J. WEST, who had been director of the research information service of the National Research Council for the past ten years, has been appointed research associate at the Institute of Paper Chemistry, Appleton, Wis., with the title of editor. He will have charge of the publications of the Institute and will also do bibliographical research.

RALPH M. PALMER, president of Ferro-Nil Corp., has been elected an alumni trustee of Brown University.

A. B. MILLER has joined the technical staff of the Hercules Powder Co.'s experimental station near Wilmington, Del. After graduating from Franklin and Marshall College, Mr. Miller joined the Armstrong Cork Co. He was employed on fundamental research work on oil and resin chemistry as related to the linoleum binder. Later he became associated with the Paraffine Companies, Inc., at San Francisco.

DONALD L. HAGUE has become associated with the Dorr Co., New York. He graduated from the chemical engineering department of Stevens Institute of Technology in 1929 and has since been employed by the Bell Telephone Co. of New Jersey.

CHARLES R. HARTE, JR., has resigned as associate editor of *Industrial and Engineering Chemistry* to enter the employment of the Standard Oil Company of Indiana. He has been assigned to the research department at Whiting, Ind.

C. E. SIMS has joined the staff of the Battelle Memorial Institute at Columbus, Ohio. Mr. Sims, who was graduated in chemical engineering from the University of Illinois, has served as assistant director of research for the American Steel Foundries at Indiana Harbor, Ind.

JOHN D. JENKINS has become associated with the Mellon Institute of Industrial Research. He is on the staff of Dr. Frederick W. Adams who has been selected as senior incumbent of the new fellowship of the Pittsburgh Plate Glass Co. Dr. Jenkins came to Mellon Institute from the Ditzler Color Co., a subsidiary of the Glass company. Dr. Harold E. Simpson, formerly a research engineer at Battelle Memorial Institute, and Dr. Kenneth B. McAlpine, who has been on the research staff of the Republic Steel Co., are also on the staff.

Colin G. Fink

WILLIAM M. COBB, JR., who is a graduate of the Georgia School of Technology, is now on the technical staff of the Hercules Powder Co., Wilmington, Del. For the past year, Mr. Cobb served as a general engineer for the Southern Iron & Equipment Co., Atlanta, Ga.

J. C. HOBBS has been made general manager in charge of all manufacturing operations of the Diamond Alkali Co., Painesville, Ohio. He replaces C. N. Windecker, who resigned. G. S. Rutherford becomes assistant to the general manager and William G. Schumacker becomes superintendent of alkali manufacture. J. T. Richards was elected a director of the company and in this connection he will serve as executive vice-president with offices at Pittsburgh.

HAROLD E. RUE and RAYMOND N. BOSTOCK, employed for a number of years with the Hoffman Beverage Co., Newark, N. J., as chief engineer and process engineer respectively, on July 1, inaugurated their own firm as consulting engineers. The firm's name is Rue & Bostock, and is located in Newark.

H. EVERARD has resigned from the Richfield Oil Co. of Calif. to accept a position with the International Bitumen

CALENDAR

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY, Montreal, Aug. 3-6.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting, Pittsburgh, Pa., September 7-12.

ELECTROCHEMICAL SOCIETY, semi-annual meeting, Niagara Falls, N. Y., October 8-10.

NATIONAL METAL CONGRESS AND EXPOSITION, Cleveland, Oct. 19-23.

AMERICAN PETROLEUM INSTITUTE, annual meeting, Chicago, Ill., November 9-12.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, Baltimore, Md., November 11-13.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS, annual meeting, Providence, R. I., December 4-5.

Co., Ltd., as refinery engineer. He will construct and operate a refinery for the manufacture of gasoline, diesel oil and asphalt.

BRADLEY STOUGHTON, formerly head of the department of metallurgy at Lehigh University, has been appointed dean of engineering.

ROBERT E. MERRILL, a recent graduate of the chemical engineering department at the University of Michigan, is now employed by the Carbide and Carbon Chemicals Corp. at South Charleston, W. Va. Howard J. Jackson and Henry W. Riel also recent Michigan graduates have been included in the company's plant training course.

R. B. ERWIN has recently started work as chemist for the International Refining Co., subsidiary of the Texas Co., at Sunburst, Mont.

SAMUEL C. LIND has assumed the duties of dean of the new School of Technology at the University of Minnesota. Dr. Lind was formerly a member of the University's chemistry department.

JOHN P. COE has been advanced from factory manager to general sales manager of the Naugatuck Chemical Division of the United States Rubber Products, Inc., New York, N. Y., Mr. Coe succeeds Ernest B. Curtis, who has joined the R. T. Vanderbilt Co., New York, to become assistant to Dr. A. A. Somerville.

GORDON C. WILLIAMS of the University of Wisconsin has been appointed assistant professor of chemical engineering at the University of Louisville.

GERALD WENDT has been appointed director of the American Institute of the City of New York by the Board of Trustees of the Institute.

VERNON BISHOP, a 1933 graduate of the University of Michigan, has resigned his position as research chemist at the Bridgeville plant of the American Cyanamid & Chemical Co., and is now associated with his father, Mr. Howard B. Bishop, president of the Sterling Products Co., Easton, Pa.

OBITUARY

OTTO PAUL AMEND died July 4 in a hospital in New York after a long illness. He was 77 years old. Mr. Amend was a son of the late Bernard G. Amend, the founder of the establishment of Eimer & Amend, a New York landmark since 1851. After graduating from Columbia University he studied in Europe for two years at the Universities of Wurzburg and Zurich. On returning to America he became associated with his father's firm and became its president in 1911. Two years ago Columbia University awarded Mr. Amend a medal for conspicuous service as an alumnus.

EDWARD N. JOHNSTON, chief of the American Chemical Warfare Service at the front during the War, died in San Francisco, Calif., on June 28. He had been ill for a long time. Col. Johnston was 60 years of age. The Twenty-third Engineers were organized and taken to France by him.

WILLIAM D. LANSING of the E. I. duPont de Nemours & Co. died May 28 after a long illness. He was 34 years old.

Dr. Lansing was born in Marseilles, Ill., and was graduated from the University of Illinois. In 1929 he joined the duPont organization and for several years was a member of the colloidal group in the fundamental research division at the Experimental Station.

J. N. HARPER, director of the American Potash Institute, died July 1 of a heart attack. His age was 62. Dr. Harper began his agricultural work in 1898 as agronomist at the Kentucky experiment station.

Otto Paul Amend

STEPHEN A. INGERSOLL died at his residence in Dalesburg, Ill., on May 16. Mr. Ingersoll was founder of the Ingersoll Steel & Disc Co.

CHARLES E. READER, chemist for the city of Cleveland, died May 25 at the United States Marine Hospital of toxic poisoning. He was 68 years old. Mr. Reader was graduated from the University of Michigan. Later he saw service in the Philippine Islands and during the Boxer Rebellion in China, and was a veteran of the Spanish-American War.

A. C. JONES died suddenly May 7. Death was caused by a cerebral embolism. Mr. Jones was born in Chicago 45 years ago and became associated with the Lebanon Steel Co. as research engineer and chief metallurgist in October, 1922, a position which he held until his death.

B. W. DUNN died May 10 at his residence in New York, N. Y. The United States Government selected Colonel Dunn to organize the Bureau of Explosives of the Association of American Railroads because of his expert knowledge of explosives. Retiring from the Army in 1911, after 30 years of service, he was appointed chief inspector of the Bureau, which post he held until recent illness forced his retirement.

LEONARD BISHTON-BOTFIELD, president of the Botfield Refractories Co., Philadelphia, died on May 5, at the age of 55 years. He had been affiliated with the refractories industry for many years, succeeding his father as president of the company in 1916.

EDWARD A. BROCKMAN of the R. & H. Chemicals Department, E. I. duPont de Nemours & Co., Inc., died on May 22 of heart disease at Seattle, Wash., where he had been living since his retirement in 1933. Mr. Brockman joined the Roessler & Hasslacher Chemical Co. in 1912 and continued his services when that organization became a part of the duPont company.

GEORGE LUTZ, chemical engineer and head of the patent department of the Grasselli Chemical Co. since 1922, died June 18 at his home in Cleveland, Ohio. Dr. Lutz was born in France and was graduated from the University of Strasbourg. He came to this country in 1918 when the French government sent him to inspect war purchases. After the War he accepted a position in the Grasselli organization in New York and was later transferred to Cleveland. Dr. Lutz, who died of a heart attack, had been ill for only a short time.

Chemical ECONOMICS

MANUFACTURING activities in the industries which are large consumers of chemicals have held up very well during the last month and deliveries of chemicals and related products have continued to hold above the volume shipped in the like period of last year. Furthermore the outlook is favorable for the third quarter of the year. Railroad freight car loadings in the third quarter of 1936 are expected to be 10.7 per cent above actual loadings of the like 1935 quarter, according to estimates compiled by the thirteen shippers' regional advisory boards.

The Northwestern, Great Lakes and Alleghany districts expected the greatest increases with estimated gains of 15 per cent, 14.1 per cent and 14.1 per cent respectively.

Of the twenty-nine commodities included in the estimate, increases are expected in twenty-six while decreases are expected in three. The twenty-six for which an increase is estimated follow: Grain, flour, meal and other mill products; cotton, citrus fruits, other fresh fruits, potatoes, live stock, poultry and dairy products, coal and coke, ore and concentrates, gravel, sand and stone, salt, lumber and forest products, petroleum and petroleum products, sugar, syrup and molasses; iron and steel, machinery and boilers, cement, brick and clay products, lime and plaster, agricultural implements and vehicles other than automobiles, automobiles, trucks and parts, fertilizers of all kinds, paper, paper board and prepared roofing, chemicals and explosives and canned goods including all canned food products.

The three commodities for which a decrease is estimated are hay, straw, and alfalfa, cotton seed and products except oil, and fresh vegetables other than potatoes.

Greater activity was reported in the coal-tar industry in May. In the first place the output of byproduct coke was up to 3,753,323 tons an increase of 8.3 per cent over the preceding month. Production of benzol, estimated from production of coke at byproduct ovens known to recover this commodity, was 9,288,946 gal. in May compared with 6,102,000 gal. in May, 1935. Production of ammonia—ammonium sulphate equivalent of all forms—was estimated at 59,229 tons as against 42,861 tons in May last year. For the first five months of this year production of ammonia was estimated at 268,209 tons with 213,664 tons for the first five months of last year or a gain of 25.5 per cent for the current year.

The automotive industry continues to operate in an active way and the output for the first five months of this year shows a percentage gain of 9.3 over the 1935 Jan.-May period. Larger demand for commercial cars is especially noted as sales for the five-month period this year amounted to 366,668 which is approximately 18.8 per cent higher than for the like period of 1935.

Very encouraging reports come from all branches of the glass trade. Glass containers which is the most important branch from a volume standpoint has maintained, for the year to date, a production more than 12 per cent higher than a year ago. Plate glass production, which reached a record high in April, fell off but little in May and is running more than 15 per cent above the 1935 rate. Data are not available for window and other flat glass production but substantial gains are reported in trade circles.

Consumption of crude rubber in April according to the Rubber Manufacturers' Association made an all-time high record of 51,897 tons. It had been expected that the amount consumed in May would surpass even the record April total but labor troubles had an adverse influence and consumption was reported at 50,482 tons which was 22.8 per cent higher than the figure for May 1935.

Domestic consumption of silk in May ran to 32,087 bales which was somewhat higher than had been anticipated. Deliveries in June, however, have been running light and probably will be less than 30,000 bales. For the year to date, consumption of silk has been about 18 per cent below that for the corresponding period of last year.

Exports of chemicals and related products continued to advance in May attaining the highest point that has been reached in several years with every important item on the list except turpentine sharing in the gain, according to Department of Commerce compilations. The value received for such exports aggregated $13,798,650 during the month compared with $11,171,000 in May, 1935, and $8,885,000 in May, 1934.

The most spectacular gain was recorded in sulphur, exports of which totalled 56,260 tons, valued at $1,071,500 in May, against 25,670 tons, valued at $490,000, in May, 1935. Exports of coal-tar products were valued at $1,278,500 in May, an increase of approximately 57 per cent over the same month last year when shipments were valued at $811,560. All items making up this group shared in the gain, particularly dye products, benzol, and crude and refined coal-tar. Dye products, valued at $620,000, accounted for half the total and compares with $558,650 for May, 1935. Exports of other finished coal-tar products aggregated $268,000 in value during the month.

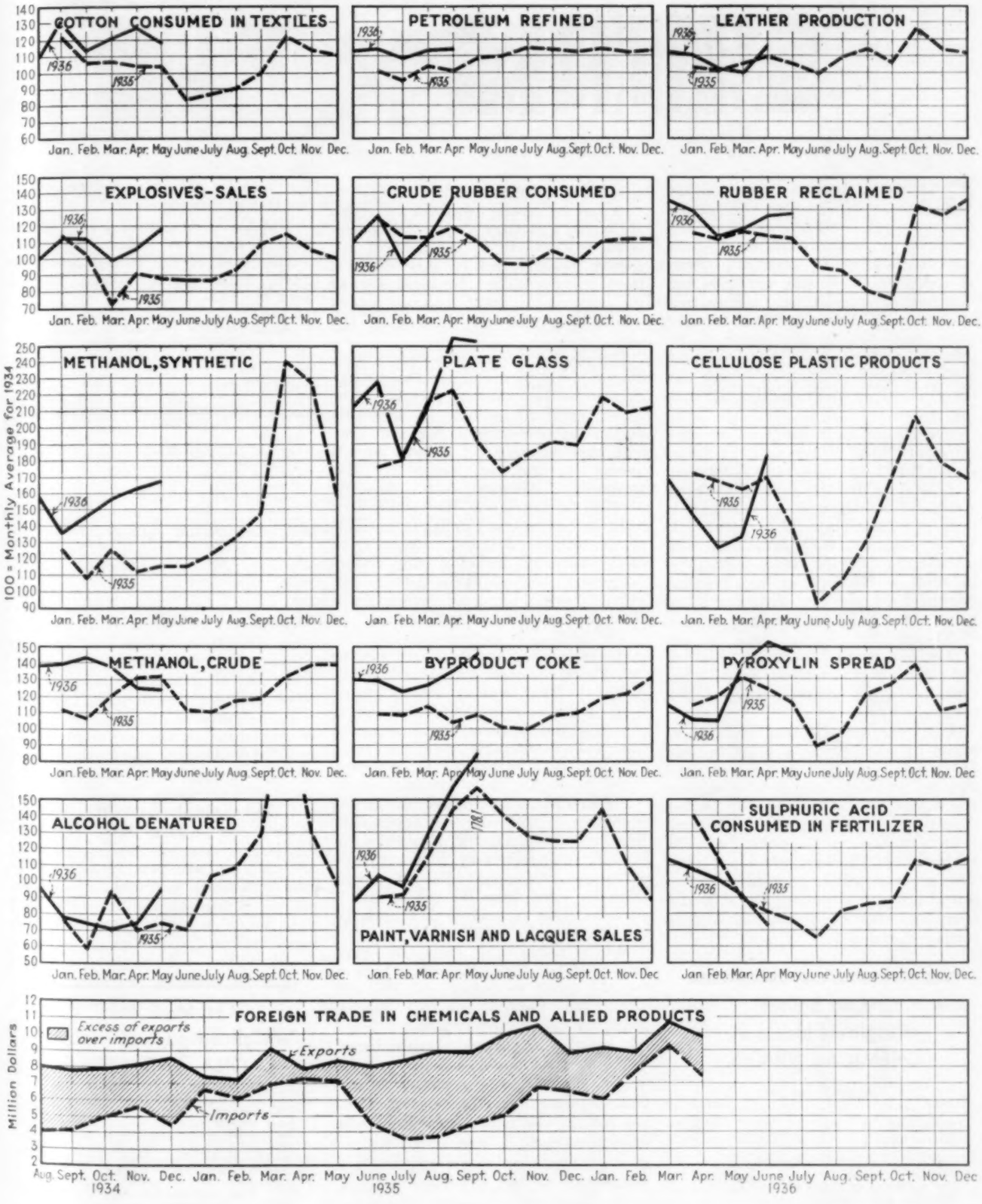
Total value of imports aggregated $12,500,000 during the month compared with $12,869,000 in April, $12,281,250 in March, and $11,962,000 in May, 1935. Paint oils, together with flaxseed were outstanding among imports in May and accounted for approximately one-third the value of all chemicals and related products purchased from foreign countries.

Production and Consumption Data for Chemical-Consuming Industries

	May 1936	May 1935	Jan.-May 1936	Jan.-May 1935	Gain Jan.-May 1936 over Jan.-May 1935 Per cent
Production					
Alcohol, denatured, 1,000 wi. gal	7,577	5,864	31,274	29,530	5.9
Automobiles, No.	460,565	361,107	2,035,921	1,861,915	9.3
Benzol, coal-tar, 1,000 gal.	9,289	6,102	40,742	30,731	32.3
Byproduct coke, 1,000 tons	3,753	2,793	16,927	13,957	21.3
Glass containers, 1,000 gr.	3,810	3,389	16,914	15,022	12.6
Plate glass, 1,000 sq. ft.	19,192	14,582	85,837	74,201	15.7
Methanol, crude, gal.	427,079	452,322	2,318,113	2,064,847	12.2
Methanol, synthetic, gal.	1,754,998	1,203,143	8,038,785	6,103,625	31.7
Paperboard, tons	289,527	262,463	1,411,748	1,312,980	7.5
Pyroxylin spread, 1,000 lb.	5,423	4,280	24,036	22,367	7.0
Rosin wood, bbl.	53,640	47,867	264,024	224,940	17.4
Turpentine, wood, bbl.	8,636	7,004	43,660	33,582	30.0
Steel barrels, No.	715,933	551,882	3,136,628	2,531,274	23.9
Consumption					
Cotton, 1,000 bales	531	470	2,765	2,451	12.8
Silk, bales	32,087	38,361	173,699	211,640	17.9*
Wool, 1,000 lb.	46,593	70,617	320,856	307,675	4.3
Paint, varnish and lacquer, sales $1,000.	40,990	36,160	151,500	137,620	10.1

* Per cent of decline.

TRENDS OF PRODUCTION AND CONSUMPTION



The MARKETS

GENERAL business went through June with less than the seasonal let-down and reports regarding consumption of chemicals indicate a similar condition. Fertilizer chemicals offered an exception to the rule with only routine buying in evidence. Interest was stimulated, however, by the announcement made late in the month to the effect that there would be a new and higher schedule of prices on potash salts for shipment from Europe for the coming season.

The new prices in detail follow: Muriate potash, 80-85 per cent, 85-90 per cent, 90-95 per cent, 95-98 per cent KCl, at 50c per unit, K_2O, equal for 2,000 pounds to $25 in bulk; manure salts, minimum 80 per cent K_2O at 55c per unit, K_2O, equal for 2,000 pounds of manure salts testing 30 per cent to $16.50; high grade kainit, minimum 20 per cent K_2O per 2,000 pounds $12 in bulk; sulphate potash, 90-95 per cent, K_2SO_4, basis 90 per cent K_2SO_4 per 2,000 pounds $36.25 in 200-pound bags; sulphate potash-magnesia per 2,000 pounds $24.75 in 200-pound bags.

A 10 per cent discount will be allowed on orders placed prior to July 15 spot delivery or for shipment from Europe on equal monthly quantities from July 1 to December 31. Orders placed prior to October 1 for delivery from October to December will be subject to a discount of 5 per cent. Two per cent will be allowed on orders placed prior to December for shipment from December 1 to January 31 with no further discounts.

Despite the recent sharp decrease in receipts of crude naphthalene from Germany, a country that formerly supplied from 35 to 50 per cent of our import requirements of this material, total receipts since the beginning of the current year have been well maintained, according to Washington figures.

During the five months ending with May imports of crude naphthalene aggregated 17½ million pounds compared with 20 million in the corresponding five months of last year and approximately 12 million pounds during the first five months of 1934, preliminary statistics show. Analysis of 1936 figures shows that while very little is being brought in from either Germany or Belgium, receipts from other countries including the United Kingdom, Czechoslovakia, Russia, and Poland, have increased substantially since the beginning of the year.

The decline in our naphthalene imports from Germany has been due to an export embargo placed on certain grades by that country at the beginning of the year to avert a threatened shortage, and Belgium which formerly imported considerable quantities from Germany is now obliged to absorb a larger proportion of its domestic output.

Commercial exploitation of Alum Mountain located near the upper Gila River in Grant County, New Mexico, is being undertaken by a recently incorporated company. The mountain takes its name from the report that it contains what is said to be the largest alum deposits in the world.

While prices for chemicals have fluctuated but little, there has been a decided uplift to prices for oils and fats. The Federal tax bill carries levies on imports of different foreign oils and this has naturally strengthened prices and no doubt will be a price factor as long as it remains in effect. Tallow, which for some months, has felt the effects of competition from foreign markets, is staging a price recovery because an excise tax of 3c a pound will be laid on future imports.

Incidentally, the Appeals Court has upheld a lower court in a decision unfavorable to a soap company which sued to compel the U. S. Treasury to return taxes paid on Philippine coconut oil.

The soap company had sued for the return of $160,879, which sum represented their share of coconut oil excise taxes on the first processing of oil originating in the Philippines. Under terms of the Revenue Act of 1934 these taxes are held in trust for the Philippine Commonwealth by the Treasury. The suit challenged the levy on this angle of the law, and contended that more than $26,000,000 paid into the fund by domestic oil processors is being used illegally.

The U. S. Bureau of Mines has issued a report on production of aluminum salts in the United States for 1935. Production data with comparisons for 1934 follow:

Aluminum Salts Produced in the U. S., 1934-1935, Short Tons

	1934	1935
Alum:		
Ammonia	4,739	5,121
Potash	3,003	2,542
Other		
Sodium aluminum sulphate	17,742	18,359
Aluminum chloride:		
Liquid	1,381	1,302
Crystal, Anhydrous	4,455	4,936
Aluminum sulphate:		
Commercial—		
General	307,758	335,677
Municipal	9,777	10,500
Iron-free	14,852	17,806
Other aluminum salts and hydrate	[1] 11,761	12,848
	[1] 375,468	409,091

[1] Revised figures.

Shipments of aluminum salts in 1935 were 408,756 short tons with apparent consumption of sodium aluminum sulphate and all grades of aluminum sulphate exceeding the amounts produced.

High lights in the way of market developments during the past month included: Drouth conditions in the grain-producing states which brought about higher prices for all vegetable oils and animal fats; the reported renewal over a long period of one of the largest contracts for caustic soda and chlorine; the passage of a bill in Louisiana which increases the severance tax on sulphur from 60 cents to $2 a ton; and a proposed plan to restrict naval stores production.

CHEM. & MET. Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

This month	**86.21**
Last month	86.24
July, 1935	87.23
July, 1934	87.79

Higher prices for potash salts were counterbalanced by lower quotations for sulphate of ammonia and nitrate. Solvents also continued to hold an unsteady price position with a lower average price ruling for turpentine.

CHEM. & MET. Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

This month	**85.27**
Last month	80.46
July, 1935	87.51
July, 1934	60.54

Advances were fairly general throughout the oil market and animal fats also commanded higher prices. Taxes to be imposed on imported oils had the effect of stimulating buying and strengthening values.

Current PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that bas's and are so designated. Prices are corrected to July 13.

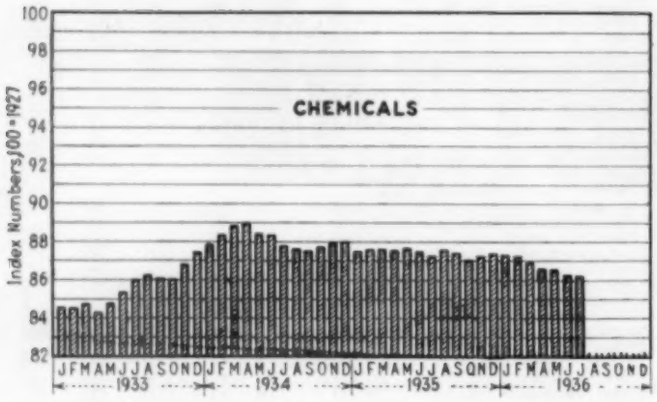
Industrial Chemicals

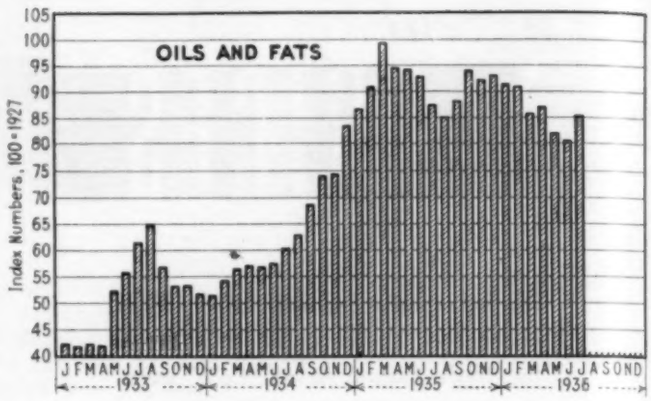
	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.08½–$0.09	$0.08½–$0.10	$0.12–$0.12½
Acid, acetic, 28%, bbl., cwt.	2.45 – 2.70	2.45 – 2.70	2.45 – 2.70
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. reagent	10.52 –10.77	10.52 –10.77	10.52 –10.77
Boric, bbl., ton	105.00–115.00	105.00–115.00	105.00–115.00
Citric, kegs, lb.	.27 – .30	.27 – .30	.28 – .31
Formic, bbl., ton	.11 – .11½	.11 – .11½	.11 – .11½
Gallic, tech., bbl., lb.	.60 – .65	.60 – .65	.60 – .65
Hydrofluoric 30% carb., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb.	.11½– .12	.11½– .12	.12 – .12½
Muriatic, 18°, tanks, cwt.	1.00 – 1.10	1.00 – 1.10	1.00 – 1.10
Nitric, 36°, carboys, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –.....	18.50 –20.00
Oxalic, crystals, bbl., lb.	.11½– .12½	.11½– .12½	.11½– .12½
Phosphoric, tech., c'bys., lb.	.09 – .10	.09 – .10	.09 – .10
Sulphuric, 60°, tanks, ton	11.00 –11.50	11.00 –11.50	11.00 –11.50
Sulphuric, 66°, tanks, ton	15.50 –.....	15.50 –.....	15.50 –.....
Tannic, tech., bbl., lb.	.20 – .30	.23 – .35	.23 – .35
Tartaric, powd., bbl., lb.	.24 – .25	.24 – .25	.24 – .25
Tungstic, bbl., lb.	1.50 – 1.60	1.50 – 1.60	1.50 – 1.60
Alcohol, Amyl	–.....	–.....	–.....
From Pentane, tanks, lb.	14.3 –.....	14.3 –.....	.15 –.....
Alcohol, Butyl, tanks, lb.	.08½–.....	.08½–.....	.13 –.....
Alcohol, Ethyl, 190 p'f., bbl., gal.	4.27½–.....	4.27½–.....	4.27½–.....
Denatured, 190 proof			
No. 1 special, dr., gal.	.34 –.....	.34 –.....	.36 –.....
Alum, ammonia, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Chrome, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Potash, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Aluminum sulphate, com, bags cwt.	1.35 – 1.50	1.35 – 1.50	1.35 – 1.50
Iron free, bg., cwt.	2.00 – 2.25	2.00 – 2.25	1.90 – 2.00
Aqua ammonia, 26°, drums, lb.	.02½– .03	.02½– .03	.02½– .03
tanks, lb.	.02½– .02¾	.02½– .02¾	.02½– .02¾
Ammonia, anhydrous, cyl., lb.	.15½– .16	.15½– .16	.15½– .16
tanks, lb.	.04½–.....	.04½–.....	.04½–.....
Ammonium carbonate, powd. tech., casks, lb.	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks., cwt.	1.25 –.....	1.30 –.....	1.175–.....
Amylacetate tech., tanks, lb.	.12 – .135	.12 – .135	.142–.....
Antimony Oxide, bbl., lb.	.13 – .14	.13½– .14	.11½– .12
Arsenic, white, powd., bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Red, powd., kegs, lb.	.15½– .16	.15½– .16	.15½– .16
Barium carbonate, bbl., ton	56.50 –58.00	56.50 –58.00	56.50 –58.00
Chloride, bbl., ton	72.00 –74.00	72.00 –74.00	72.00 –74.00
Nitrate, cask, lb.	.03½– .09	.08½– .09	.08½– .09
Blanc fixe, dry, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt.	2.00 – 2.10	2.00 – 2.10	1.90 – 2.00
Borax, gran., bags, ton	44.00 –49.00	44.00 –49.00	44.00 –49.00
Bromine, cs., lb.	.36 – .38	.36 – .38	.36 – .38
Calcium acetate, bags	2.10 –.....	2.10 –.....	2.10 –.....
Arsenate, dr., lb.	.06 – .07	.06 – .07	.06 – .07
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	20.00 –33.00	20.00 –33.00	20.00 –33.00
flake, dr., del., ton	22.00 –35.00	22.00 –35.00	22.00 –35.00
Phosphate, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb.	.05½– .06	.05½– .06	.05½– .06
Tetrachloride drums, lb.	.05½– .08½	.05½– .06	.05½– .06
Chlorine, liquid, tanks, wks., lb.	2.15 –.....	2.15 –.....	2.00 –.....
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb.	1.41 – 1.51	1.41 – 1.51	1.35 – 1.40
Copperas, bgs., f.o.b., wks., ton	15.00 –16.00	15.00 –16.00	14.00 –15.00
Copper carbonate, bbl., lb.	.08½– .16	.08½– .16	.08½– .16
Sulphate, bbl., cwt.	4.00 – 4.25	4.00 – 4.25	3.85 – 4.00
Cream of tartar, bbl., lb.	.16½– .17	.16½– .17	.16½– .17
Diethylene glycol, dr., lb.	.16½– .20½	.16½– .20½	.16½– .20½
Epsom salt, dom., tech., bbl., cwt.	1.80 – 2.00	1.80 – 2.00	2.10 – 2.15
Ethyl acetate, drums, lb.	.07 –.....	.07 –.....	.08½–.....
Formaldehyde, 40%, bbl., lb.	.06 – .07	.06 – .07	.06 – .07
Furfural, dr., lb.	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, ref. drums, lb.	.16 – .18	.16 – .18	.16 – .18
Glaubers salt, bags, cwt.	.85 – 1.00	.85 – 1.00	1.00 – 1.10
Glycerine, c.p., drums, extra, lb.	.14½– .15	.14½– .15	.14 – .14½
Lead:			
White, basic carbonate, dry casks, lb.	.06½–.....	.06½–.....	.06½–.....
White, basic sulphate, sck., lb.	.06 –.....	.06 –.....	.06 –.....
Red, dry, sck, lb.	.07 –.....	.07 –.....	.06½–.....
Lead acetate, white crys., bbl., lb.	.10½– .11	.10½– .11	.10½– .11
Lead arsenate, powd., bbl., lb.	.09 – .10	.09 – .10	.09 – .10
Lime, chem., bulk, ton	8.50 –.....	8.50 –.....	8.50 –.....
Litharge, pwd., csk., lb.	.06 –.....	.06 –.....	.05½–.....
Lithophone, bags, lb.	.04½– .05	.04½– .05	.04½– .05
Magnesium carb., tech., bags, lb.	.06 – .06½	.06 – .06½	.06 – .06½
Methanol, 95%, tanks, gal.	.33 –.....	.33 –.....	.33 –.....
97%, tanks, gal.	.34 –.....	.34 –.....	.34 –.....
Synthetic, tanks, gal.	.35½–.....	.35½–.....	.35½–.....
Nickel salt, double, bbl., lb.	.13 – .13½	.13 – .13½	.12½– .13
Orange mineral, csk., lb.	.10 –.....	.10 –.....	.09½–.....
Phosphorus, red, cases, lb.	.44 – .45	.44 – .45	.44 – .45
Yellow, cases, lb.	.28 – .32	.28 – .32	.28 – .32
Potassium bichromate, casks, lb.	.08½– .09	.08½– .09	.07½– .08½
Carbonate, 80–85%, calc. csk., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Chlorate, powd., lb.	.08 – .08½	.08 – .08½	.08½– .09
Hydroxide (c'stic potash) dr., lb.	.06½– .06¾	.06½– .06½	.06½– .06¾
Muriate, 80% bgs., ton	23.00 –.....	23.00 –.....	22.00 –.....
Nitrate, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb.	.18 – .19	.18 – .19	.18 – .19
Sal ammoniac, white, casks, lb.	.04½– .05	.04½– .05	.04½– .05
Salsoda, bbl., cwt.	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt.	1.23 –.....	1.23 –.....	1.23 –.....
Dense, bags, cwt.	1.25 –.....	1.25 –.....	1.25 –.....
Soda, caustic, 76%, solid, drums, contract, cwt.	2.60 – 3.00	2.60 – 3.00	2.60 – 3.00
Acetate, works, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Bicarbonate, bbl., cwt.	1.85 – 2.00	1.85 – 2.00	1.85 – 2.00
Bichromate, casks, lb.	.06½– .07	.06½– .07	.05½– .06½
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Bisulphite, bbl., lb.	.03½– .04	.03½– .04	.03 – .04
Chlorate, kegs, lb.	.06½– .06¾	.06½– .06¾	.06½– .06¾
Chloride, tech., ton	12.00 –14.75	12.00 –14.75	12.00 –14.75
Cyanide, cases, dom., lb.	.15½– .16	.15½– .16	.15½– .16
Fluoride, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., cwt.	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt.	2.90 – 3.00	2.90 – 3.00	3.25 – 3.40
Nitrate, bags, cwt.	1.290–.....	1.325–.....	1.275–.....
Nitrite, casks, lb.	.07½– .08	.07½– .08	.07½– .08
Phosphate, dibasic, bbl., lb.	.022– .023	.022– .023	.022– .024
Prussiate, yel. drums, lb.	.11½– .12	.11½– .12	.11½– .12
Silicate (40° dr.) wks., cwt.	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, cyrs., bbl., lb.	.02½– .02½	.02½– .02½	.02½– .02½
Sulphur, crude at mine, bulk, ton	18.00 –.....	18.00 –.....	18.00 –.....
Chloride, dr., lb.	.03½– .04	.03½– .04	.03½– .04
Dioxide, cyl., lb.	.06½– .08	.06½– .08	.07 – .07½
Flour, bag, cwt.	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb.	.47 –.....	.50 –.....	.54 –.....
Crystals, bbl., lb.	.34 –.....	.34½–.....	.38½–.....
Zinc, chloride, gran., bbl., lb.	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb.	.09 – .11	.09 – .11	.09 – .11
Cyanide, dr., lb.	.36 – .38	.36 – .38	.36 – .38
Dust, bbl., lb.	.069– .07	.069– .07	.063– .07
Zinc oxide, lead free, bag., lb.	.05 –.....	.05 –.....	.05½–.....
5% lead sulphate, bags, lb.	.04½–.....	.04½–.....	.05½–.....
Sulphate, bbl., cwt.	2.65 – 3.00	2.65 – 3.00	2.75 – 3.00

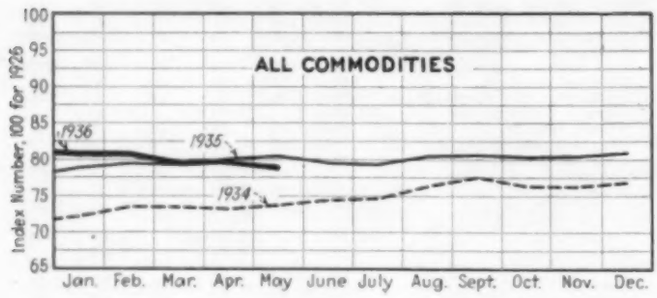
Oils and Fats

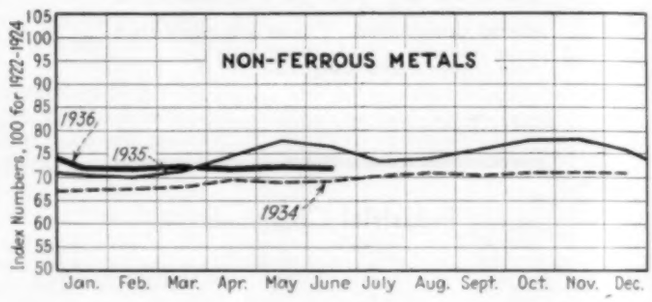
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.10 –$0.11	$0.10 –$0.11	$0.09½–$0.10
Chinawood oil, bbl., lb.	.19½–.....	.18½–.....	.15 –.....
Coconut oil, Ceylon, tanks, N. Y. lb.	.04½–.....	.04 –.....	.03½–.....
Corn oil crude, tanks, (f.o.b. mill). lb.	.08½–.....	.08 –.....	.08½–.....
Cottonseed oil, crude (f.o.b. mill). tanks, lb.	.08½–.....	.07½–.....	.08½–.....
Linseed oil, raw car lots, bbl., lb.	.101–.....	.094–.....	.093–.....
Palm, casks, lb.	.04½–.....	.04½–.....	.04½–.....
Palm kernel, bbl., lb.	.05½–.....	.05½–.....	.05½–.....
Peanut oil, crude, tanks (mill), lb.	.08½–.....	.08 –.....	.09½–.....
Rapeseed oil, refined, bbl., gal.	.63 –.....	.51 –.....	.42 –.....
Soya bean, tank, lb.	.08½–.....	.06 –.....	.093–.....
Sulphur (olive foots), bbl., lb.	.08 –.....	.08 –.....	.08 –.....
Cod, Newfoundland, bbl. gal.	.40 –.....	.40 –.....	.35 –.....
Menhaden, light pressed, bbl., lb.	.064–.....	.06 –.....	.067–.....
Crude, tanks (f.o.b.factory), gal.	.30 –.....	.32 –.....	.28 –.....
Grease, yellow, loose, lb.	.05½–.....	.03½–.....	.06½–.....
Oleo stearine, lb.	.08½–.....	.07 –.....	.09 –.....
Red oil, distilled, d.p. bbl., lb.	.09½–.....	.08½–.....	.09½–.....
Tallow, extra, loose, lb.	.05½–.....	.04½–.....	.08½–.....

CHEM. & MET.'S WEIGHTED PRICE INDEXES









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 –$0.65	$0.60 –$0.65	$0.60 –$0.62
Refined, bbl., lb.	.80 – .85	.80 – .85	.80 – .85
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.14½– .15	.14½– .15	.14½– .15
Aniline salts, bbl., lb.	.24 – .25	.24 – .25	.24 – .52
Benzaldehyde, U.S.P., dr., lb.	1.10 – 1.25	1.10 – 1.25	1.10 – 1.25
Benzidine base, bbl, lb.	.65 – .67	.65 – .67	.65 – .67
Benzoic acid, U.S.P., kgs., lb.	.48 – .52	.48 – .52	.48 – .52
Benzyl chloride, tech., dr., lb.	.30 – .35	.30 – .35	.30 – .35
Benzol, 90%, tanks, works, gal.	.18 – .20	.18 – .20	.15 – .16
Beta-naphthol, tech., drums, lb.	.24 – .27	.24 – .27	.22 – .24
Cresol, U.S.P., dr., lb.	.10 – .11	.10 – .11	.11 – .11½
Cresylic acid, 99%, dr., wks., gal.	.68 – .70	.63 – .67	.42 – .43
Diethylaniline, dr., lb.	.55 – .58	.55 – .58	.55 – .58
Dinitrophenol, bbl., lb.	.29 – .30	.29 – .30	.29 – .30
Dinitrotoluen, bbl., lb.	.16 – .17	.16 – .17	.16 – .17
Dip oil, 25%, dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.38 – .40	.38 – .40	.38 – .40
H-acid, bbl., lb.	.65 – .70	.65 – .70	.65 – .70
Naphthalene, flake, bbl., lb.	.07 – .07½	.07 – .07½	.05½– .06
Nitrobenzene, dr., lb.	.08½– .09	.08½– .09	.08½– .10
Para-nitraniline, bbl., lb.	.51 – .55	.51 – .55	.51 – .55
Phenol, U.S.P., drums, lb.	.14½– .15	.14½– .15	.14½– .15
Picric acid, bbl., lb.	.30 – .40	.30 – .40	.30 – .40
Pyridine, dr., gal.	1.10 – 1.15	1.10 – 1.15	1.10 – 1.15
Resorcinal, tech., kegs, lb.	.65 – .70	.65 – .70	.65 – .70
Salicylic acid, tech., bbl., lb.	.40 – .42	.40 – .42	.40 – .42
Solvent naphtha, w.w., tanks, gal.	.26 –.....	.26 –.....	.26 –.....
Tolidine, bbl., lb.	.88 – .90	.88 – .90	.88 – .90
Toluene, tanks, works, gal.	.30 –.....	.30 –.....	.30 –.....
Xylene, com., tanks, gal.	.30 –.....	.30 –.....	.30 –.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grid., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb.	.15½ – .17	.15 – .17	.12½– .13
China clay, dom., f.o.b. mine, ton	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 – .20	.04 – .20	.04 – .20
Prussian blue, bbl., lb.	.37 – .38	.37 – .38	.36½– .37
Ultramarine blue, bbl., lb.	.10 – .26	.10 – .26	.06 – .32
Chrome green, bbl., lb.	.26 – .27	.26 – .27	.26 – .27
Carmine red, tins, lb.	4.00 – 4.40	4.00 – 4.40	4.00 – 4.40
Para toner, lb.	.80 – .85	.80 – .85	.80 – .85
Vermilion, English, bbl., lb.	1.59 – 1.60	1.59 – 1.60	1.52 – 1.56
Chrome yellow, C. P., bbl., lb.	.12 – .14	.12 – .14	.15 – .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 – .08½	.07 – .08½	.07 – .08½
Gum copal Congo, bags, lb.	.09 – .10	.09 – .10	.09 – .10
Manila, bags, lb.	.09 – .10	.09 – .10	.16 – .17
Damar, Batavia, cases, lb.	.13½ .16	.15½– .16	.15½– .16
Kauri No. 1 cases, lb.	.19 – .25	.20 – .25	.20 – .25
Kieselguhr (f.o.b. N. Y.), ton.	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton.	50.00 –.....	50.00 –.....	50.00 –.....
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 –...07
Imported, casks, lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H., bbl.	6.25 –.....	5.65 –.....	5.60 –.....
Turpentine, gal.	.41 –.....	.41 –.....	.48½–.....
Shellac, orange, fine, bags, lb.	.25 –.....	.25 –.....	.25 –.....
Bleached, bonedry, bags, lb.	.18 –.....	.19 –.....	.21 –.....
T. N. bags, lb.	.14½–.....	.14½–.....	.14 –.....
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton.	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 –.....	13.75 –.....	13.75 –.....

INDUSTRIAL NOTES

JULIEN P. FRIEZ & SONS, INC., Baltimore, has appointed W. L. Byrne, 4 Smithfield St., Pittsburgh, and Russell R. Gannon Co., 519 Main St., Cincinnati, as representatives of its air conditioning instruments and controls department.

ROBINS CONVEYING BELT CO., New York, is now represented in several Western and Southwestern states by the Mine and Smelter Supply Co., Denver, Colo.

PHILADELPHIA DRYING MACHINERY CO., Philadelphia, Industrial Furnace Division, is now represented in the Detroit territory by the Beeman Combustion Supply Co.

OLDBURY ELECTRO-CHEMICAL CO., Niagara Falls, has opened a New York office at 22 East 40th St. Joseph Turner & Co., will retain a selling agency for the company's products which they have heretofore distributed.

THE DORR CO., has moved its main office to 570 Lexington Ave., New York. The engineering department also has been moved from Denver to New York. Research and development will continue to be handled at Westport, Conn.

STORMS-HARVEY EQUIPMENT CO., INC., New York, has moved to 123 Bleecker St.

IMPERIAL ELECTRIC CO., Akron, Ohio, has appointed George M. Snodgrass sales manager.

BABCOCK & WILCOX TUBE CO., Beaver Falls, Pa., recently appointed Edward A. Livingstone manager of alloy tube sales.

AMERICAN DISTRICT STEAM CO., North Tonawanda, N. Y., has placed Mayer Godchaux, Audubon Bldg., New Orleans, in charge of sales in southern Louisiana.

AMERICAN CYANAMID & CHEMICAL CO., New York, has acquired the wax refining business of the Harrison Refining Co., Belleville, N. J.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1936	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$37,000	.....	$463,000	$669,000
Middle Atlantic	2,644,000	$156,000	6,946,000	8,026,000
South	10,205,000	1,585,000	11,432,000	10,858,000
Middle West	2,301,000	365,000	6,460,000	5,342,000
West of Mississippi	50,000	387,000	5,858,000	6,234,000
Far West	387,000	602,000	3,930,000	4,782,000
Canada	.....	1,075,000	12,168,000	9,112,000
Total	$15,624,000	$4,170,000	$47,257,000	$45,023,000

PROPOSED WORK

BIDS ASKED

Chemistry Building—California Institute of Technology, 1201 East California St., Pasadena, Calif., is naving plans prepared by Mayers, Murray & Phillips, Archts., and Bertram G. Goodhue, Associate Archt., 2 West 47th St., New York, N. Y., for the construction of a 3 story, 59x120 ft. addition to Chemistry Building. Estimated cost $350,000.

Coal Tar Products Plant—The Reilly Tar & Chemical Corp., 1615 Merchants Bank Bldg., Indianapolis, Ind., has acquired a site in the Cuyahoga Valley at Cleveland, O., and will construct a plant. Estimated cost will exceed $200,000.

Distillery—H. H. Frederick Distilleries Co., Harrison, O., contemplates improvements to its plant. Estimated cost will exceed $40,000.

Distillery—Penn-Maryland Corp., 7818 Anthony Wayne Ave., Cincinnati, O., plans to construct an 8 story distillery. Estimated cost $250,000.

Factory—The Air Reduction Sales Co., Pacific Ave. and Forest St., Jersey City, N. J., has acquired six lots adjoining its plant and contemplates improvements. Estimated cost will exceed $37,000. Maturity indefinite.

Factory—Republic Bronze Powder Co., J. W. Fraser, Pres., 3000 Woodhill Rd., Cleveland, O., contemplates the construction of a factory at Painesville, O. E. G. Hoefler, 5005 Euclid Ave., Cleveland, Archt.

Factory—Solvay Process Co., Solvay, N. Y., plans to construct an addition to its plant. Estimated cost will exceed $500,000.

Glass Factory—C. W. Meyer, Stone Mountain, Ga., contemplates the construction of a glass factory in the Atlanta territory. Estimated cost $2,000,000.

Glass Factory—Pittsburgh Plate Glass Co., 235 East Pittsburgh Ave., Milwaukee, Wis., plans to construct a 4 story, 60x220 ft. factory.

Kiln Tunnel—Niles Fire Brick Co., Niles, O., has had plans prepared by Robertson Co., Hanna Bldg., Cleveland, O., for the construction of a kiln tunnel.

Kraft and Pulp Mill—Container Corporation of America, 111 West Washington St., Chicago, Ill., has acquired a site at Fernandina, Fla., and plans to construct a kraft and pulp mill. G. R. Hardy, 305 Bway., New York, N. Y. Engr. Estimated cost $5,500,000.

Laboratory—Lehigh University, Bethlehem, Pa., plans to construct an addition to its laboratory. Estimated cost will exceed $40,000.

Laboratory—Linde Air Products Co., 30 East 42nd St., New York, N. Y., contemplates the construction of a laboratory and plant on Woodward Ave., Tonawanda, N. Y. Estimated cost $2,000,000.

Laboratory—Merrimac Chemical Co., Chemical Lane, Everett, Mass., is receiving bids for the construction of a 2 and 3 story, 50x130 ft. laboratory building.

Rayon Mill—Tubize Chatillon Corp., 2 Park Ave., New York, N. Y., plans to recondition and improve its knitting and dyeing works at Hopewell, Va. Estimated cost including equipment $150,000.

Rayon Mill—Tubize Chatillon Corp., 2 Park Ave., New York, N. Y., plans to construct a viscose yarn unit at Rome, Ga. Estimated cost $2,000,000.

Phosphate Refining Plant — Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., is having plans prepared for the construction of a phosphate refining plant near Columbia, Tenn. Estimated cost $500,000.

Tung Oil Plant—China Tung Oil Co., H. W. Bennett, Pres., Gainesville, Fla., plans to construct a tung oil plant at Brooker, Fla. Estimated cost $55,000.

Rectifying Plant—Coastal Refining Co., Port Isabel, Tex., plans to construct a 2 story, 100x160 ft. vapor rectification plant. Estimated cost $50,000.

Drum Cleaning Plant—General Petroleum Corp., 519 19 St., Oakland, Calif., is receiving bids for the construction of a 1 story, 40x60 ft. drum cleaning plant at Parr Terminal.

Refinery—National Refining Co., Findlay, O., plans to construct an addition to its refinery and install atmospheric vacuum distillation unit. G. F. Arnold, Supt. Estimated cost $200,000.

Refinery—Standard Oil Co. of Ohio, 526 High St., Toledo, O., plans to construct a distilling and cracking unit at its refinery. Estimated cost $1,500,000.

Refinery—Waverly Oil Works Co., S. M. Cockel, Pres., 54th St. and AV. R. R., Pittsburgh, Pa., are having plans prepared by Rust Engineering Co., Clark Bldg., Pittsburgh, Pa., for the construction of an oil refinery including power plant and dewaxing plant.

Repressuring Plants—Walter S. Borland, 163 East Bissell Ave., Oil City, Pa., and Claude Slicker, Knox, Pa., have acquired 300 acres of oil property in Shamburg Field, east of Titusville, Pa., including 70 producing wells. The owners plan to install air and gas type pressure plants to force recovery of crude oil from the old wells, and will purchase gas engines, air compressors, piping and other equipment. Estimated cost $30,000.

CONTRACTS AWARDED

Blast Furnace—Hamilton Coke & Iron Co., J. A. Lovett, Gen. Mgr., New Miami, O., has awarded the contract for new blast furnace to have a capacity of 700 tons per day to Arthur G. McKee Co., 2422 Euclid Ave., Cleveland, O. Estimated cost $300,000.

Breakdown Clipping Plant—Rainier Pulp & Paper Co., Shelton, Wash., has awarded the contract for the construction of a breakdown clipping plant to Roy Kimbel, Shelton. This is first unit of plant estimated to cost $500,000.

Cement Plant—Universal Atlas Portland Cement Co., Birmingham, Ala., will improve Leeds Mill cement plant. Work will be done by day labor and separate contracts. Estimated cost $1,500,000.

Distillery—Columbia Fruit & Distillery Co., Salem, Ore., has awarded the contract for the construction of a distillery to H. G. Carl, Salem. Estimated cost $65,000.

Factory—General Plastics, Inc., Walek Rd., North Tonawanda, N. Y., has awarded the contract for an addition to its factory to George W. Morris Construction Corp., Jackson Bldg., Buffalo.

Factory—The Linde Air Products Co. of Texas, 6119 Harrisburg Blvd., Houston, Tex., has awarded the contract for an addition to its plant to Tellepsen Construction Co., Houston. Estimated cost including equipment $37,000.

Factory—Ohio Bronze Powder Co., G. F. Glass, Pres., 1120 East 150th St., Cleveland, O., has awarded the contract for an addition to its factory to J. Reuss, 390 Lloyd Rd., Cleveland. Estimated cost $30,000.

Factory — Porcelain Manufacturing Co., Huff Ave., Greensburg, Pa., has awarded the contract for a 40x120 ft. top floor addition to its factory to Westmoreland Construction Co., Pittsburgh and Madison Sts., Greensburg.

Factory—Roman Cleanser Co., 9101 Delmar Ave., Detroit, Mich., has awarded the contract for the construction of a factory for the manufacture of washing fluids to Barton-Malow Co., 1900 East Jefferson Ave., Detroit. Estimated cost $50,000.

Factory—Climax Molybdenum Co., Climax, Colo., has awarded the contract for the construction of mine and mill change buildings, boiler house, hospital, recreation building, etc., to Thomas Bate & Co., 2311 10th St., Denver, Colo. Estimated cost $350,000.

Gas Plant—Town, Ozark, Ala., has awarded the contract for the construction of an air gas plant and distribution system to Algernon Blair, Montgomery, Ala., $44,591.

Glass Factory—Fairmount Glass Works, J. H. Rau, Pres. and Mgr., South Keystone Ave. and Belt Ry., Indianapolis, Ind., has awarded the contract for an addition to its glass jar factory to Service Construction Co., P. O. Box 1101, Indianapolis, $47,642.

Mill—International Nickel Co. of Canada, Ltd., Bank of Commerce Bldg., Toronto, Ont., Can., has awarded the general contract for the construction of a 100x800 ft. electrolytic building, a 100x300 ft. warehouse, 95x236 ft. Whitehead unit for monel metal at Copper Cliff, Ont., to Fraser Brace Engineering Co., Ltd., 107 Craig St., W., Montreal, Que. Estimated cost $1,000,000.

Paper Plant—U. S. Gypsum Co., 300 West Adams St., Chicago, Ill., has awarded the contract for the construction of a paper plant at Oakmont, Pa., to W. T. Grange Construction Co., Keenan Bldg., Pittsburgh; machinery to Bagley & Sewall, Watertown, N. Y. Estimated cost $25,000.

Refinery—Big West Oil Co., Hutton Bldg., Spokane, Wash., has awarded the contract for enlarging its crude charging capacity and its Dubbs cracking capacity at Kevin, Mont., to Ralph M. Parsons Co., 310 South Michigan Ave., Chicago, Ill. Work involves conversion of Dubbs unit from single coil to two coil selective cracking operation and building light oil cracking furnace, installing additional hot oil pump and high pressure pump for charging straight-run gasoline to the furnace.

Refinery—Conewango Refining Co., H. R. Lewis, Pres., Warren, Pa., has awarded the contract for the construction of a barrel house to E. F. Anundsen, 308 West Main St., Sheffield, Pa. Estimated cost $20,000.

Refinery—Pace Oil Refiners Ltd., Carman, Man., Can., plans to construct an oil refinery. W. R. Milton, Gen. Mgr. Estimated cost $75,000.

Refinery—Quaker State Refining Co., W. R. Reitz in charge, 552 Chambers Bldg., Oil City, Pa., will construct a dewaxing plant and power plant. Separate contracts will be awarded for the work. E. B. Badger & Sons, 271 Madison Ave., New York, N. Y., Engrs.

Rubber Factory—Gillette Rubber Co., Eau Claire, Wis., has awarded the contract for constructing a 200x600 ft. second floor to factory, also 50x130 ft. addition, to Hoeppner & Bartlett Co., Eau Claire.

Oil Storage Building—National Refining Co., 793 Kentucky St., Memphis, Tenn., has awarded the contract for the construction of a 2 story, 4,086 ft. oil storage building to Meers & Wallenta Co., Memphis; seven tanks to Newberry Equipment Co., Memphis. Estimated cost $40,000.

Consumption of Naval Stores Increased in 1935–36

ANNUAL report, recently issued by the United States Department of Agriculture, contains data on production, distribution, consumption, and stocks of naval stores. Some changes have been made in the tables showing consumption and stocks in the hands of consumers. Abattoirs, asphaltic products, ester gum, furniture, insecticides and disinfectants, and rubber have been added as classes of consumption. Figures for consumption and stocks of these classes heretofore reported under other classes have been properly segregated.

There are included in this issue tables prepared by the Agricultural Adjustment Administration showing average monthly and season's prices of gum spirits of turpentine and gum rosin. A summary of production and stocks supplied by the Bureau of Foreign and Domestic Commerce in some of the leading foreign-producing countries has also been added.

Domestic consumption of turpentine for the 1935-36 season amounted to 352,238 50-gal. bbl. which represents an increase over the totals consumed in the two preceding seasons. Apparent consumption of rosin in this country for the same period is placed at 1,287,413 500-lb. bbl. which also overtops the 1934-35 and 1933-34 totals.

Total production of turpentine in 1935-36 was 602,908 bbl. of which 497,000 bbl. was gum spirits. The output of rosin reached a total of 2,276,491 bbl. of which 1,647,000 bbl. was gum rosin. Details for production of turpentine and rosin by other methods will be found in the accompanying table.

Eight states are enumerated as producers of naval stores and in the case of gum turpentine the percentage to total production was: Georgia, 55.42 per cent; Florida, 28.46 per cent; Alabama, 9.19 per cent; South Carolina, 3.36 per cent; Mississippi, 2.02 per cent; Louisiana, 0.95 per cent; Texas, 0.41 per cent; North Carolina, 0.19 per cent.

Stocks of turpentine on March 31, 1936 were reported at 230,136 bbl. or an increase of 38,777 bbl. for the fiscal year. Stocks of rosin were 765,807 bbl. or a decline of 213,123 bbl. for the crop year. Stocks of turpentine on March 31 were held: 8,032 bbl. at gum stills; 157,750 bbl. at southern ports and interior yards; 12,696 bbl. at wood plants; and 31,404 bbl. at other distributing points.

The report includes a tabular presentation of average prices for the naval stores years from 1921-22 through 1935-36.

Summary of Supply, Distribution and Carryover of Turpentine and Rosin
(By naval stores seasons April 1-March 31)

	Turpentine			Rosin		
	1935–36	1934–35	1933–34	1935–36	1934–35	1933–34
		50-gal. bbl.			500-lb. bbl.	
SUPPLY AND DISTRIBUTION						
Carryover April 1	191,359	132,265	136,853	978,930	928,654	847,018
Production	602,908	603,093	624,761	2,276,491	2,229,122	2,297,337
Imports	12,490	10,559	10,007	2,236	2,526	3,936
Available Supply	806,757	745,917	771,621	3,257,657	3,160,302	3,148,291
Less Carryover March 31	230,136	191,359	132,265	765,807	978,930	928,654
Apparent Total Consumption	576,621	554,558	639,356	2,491,850	2,181,372	2,219,637
Less Exports	224,383	207,284	300,201	1,204,437	1,057,321	1,199,642
Apparent U. S. Consumption	352,238	347,274	339,155	1,287,413	1,124,051	1,019,995
PRODUCTION AND IMPORTS						
Gum	497,000	510,000	526,000	1,701,187*	1,734,000*	1,788,060*
Wood	105,908	93,093	98,761	575,304	495,122	509,277
Imports	12,490	10,559	10,007	2,236	2,526	3,936
Total	615,398	613,652	634,768	2,278,727	2,231,648	2,301,273
CARRYOVER (STOCKS)						
Carryover April 1	191,359	132,265	136,853	978,930	928,654	847,018
Carryover March 31	230,136	191,359	132,265	765,807	978,930	928,654
Increase	38,777	59,094			50,276	81,636
Decrease			4,588	213,123		

* Includes reclaimed rosin.

Reported Consumption of Turpentine and Rosin in United States
(Combined Gum and Wood Products)

	Turpentine			Rosin		
	1935–36	1934–35	1933–34	1935–36	1934–35	1933–34
		50-gal. bbl.			500-lb. bbl.	
Abattoirs[1]	....	....	....	2,375	....	....
Adhesives and plastics[2]	749	....	....	26,662	....	....
Asphaltic products[3]	8	....	....	1,808	....	....
Automobiles and wagons	890	869	853	2,855	1,473	1,505
Chemicals and Pharmaceuticals	1,346	802	748	3,370	3,056	3,889
Ester Gum[4]	13	....	....	98,758	....	....
Foundries and foundry supplies	326	167	206	11,218	2,385	1,670
Furniture[4]	843	....	....	123	....	....
Insecticides and disinfectants[4]	600	....	....	5,357	....	....
Linoleum and floor covering	39	6	2	24,650	15,854	19,530
Matches	0	0	0	2,869	1,585	3,160
Oils and Greases	225	191	201	34,345	31,833	30,634
Paint, Varnish and Lacquer	66,538	51,725	51,365	147,245	176,000	168,640
Paper and paper size	....	43	29	357,143	337,000	320,940
Printing ink	200	376	389	15,112	11,872	11,677
Railroads and Shipyards[5]	3,875	718	511	242	60	39
Rubber[4]	1,114	....	....	2,544	....	....
Shoe polish and Shoe materials[6]	10,234	12,678	11,516	9,871	1,130	850
Soap	125	200	113	278,750	283,465	264,173
Other Industries	803	898	830	2,284	3,007	3,045
Total Industrial Reported[7]	87,928	69,305	67,388	1,027,601	884,835	841,271
Not Accounted for[8]	264,928	277,969	271,767	259,812	239,216	178,726

[1] Included in "Other Industries" in 1934–35 and 1933–34.
[2] Reported as "Sealing wax, pitch, insulation and plastics" in 1934–35 and 1933–34.
[3] Included in "Paint and Varnish" in 1934–35 and 1933–34.
[4] Not previously reported.
[5] Reported as "Shipyards and Carshops" in 1934–35 and 1933–34.
[6] Figures on "Shoe materials" other than "Shoe Polish" not previously reported.
[7] Compiled from reports by consumers, for calendar years 1935, 1934 and 1933. Since industrial consumption is fairly uniform, no material error is involved in using these figures on the season basis.
[8] Principally unreported distribution of turpentine through retailers and of rosin for unreported industrial consumption, also for distribution through retailers.

Production by Grades
PRODUCTION

	Turpentine			Rosin		
	1935–36	1934–35	1933–34	1935–36	1934–35	1933–34
		50-gal. bbl.			500-lb. bbl.	
Gum	497,000	510,000*	526,000*	1,647,000	1,700,000*	1,753,000*
Reclaimed gum	....	....	....	54,187	34,000*	35,060*
Steam dist. wood	88,875	77,494*	83,561*	575,304	495,122	509,277
Sulphate wood	11,712	9,832	9,000	....	....	....
Dest. dist. wood	5,321	5,767	6,200	....	....	....
Total	602,908	603,093	624,761	2,276,491	2,229,122	2,297,337